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THE SCIENTIFIC MONTHLY

OCTOBER. 1922

THE CONSERVATION AND PROPER UTILIZATION OF OUR NATURAL RESOURCES[1]

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THE natural resources of the United States are the richest and most varied of any country in the world. It is only necessary to call attention to our great coal and oil fields and natural gas, our varied mineral resources, wonderful forests of hard and soft woods, our multitude of species of wild game mammals and birds and fur-bearing animals, the hundreds of species of useful insectivorous and predaceous birds, and the rich fisheries of our Atlantic, Gulf and Pacific coasts, Great Lakes and other interior waters, to enable us to realize that our country has been exceedingly blessed in this regard.

And this very richness of natural resources has had much to do with making us the most short-sighted, the most extravagant and the most wasteful people in all the world. There is not one of our natural resources which, in the beginning of the development of the country, was not handled in very wasteful ways; in numerous instances so wasteful and destructive that the resource was wiped out almost, if not quite, entirely. Such were the Buffalo, Wild Pigeon, Atlantic Salmon, Wild Turkey, Gray Squirrel, Sturgeon, Sea Otter, natural gas, white pine and many others that might be mentioned.

It is now too late to do anything to correct the mistakes with some of the species that were once valuable assets to our people, because they are now entirely extinct, or are species whose well-being depends upon an environment which has passed and can not be restored. But there are many species of the native flora and fauna with which it is not too late and which, with proper care,

[1] Presidential address delivered June 22, 1922, at the Salt Lake City meeting of the American Association for the Advancement of Science.

can again be restored to something like their former abundance and usefulness.

THE FORESTS

It was my good fortune to be brought up in the middle Wabash Basin, a region in which was then found perhaps the greatest hardwood forest the world has ever seen. Great oaks, hickories and elms, each of several species, magnificent sycamores, black walnuts, yellow poplars or tulip trees, splendid gray ash and swamp ash, three or more species of maples or sugar-trees, poplars or cottonwoods of half a dozen species, some of them magnificent trees, and, scarcely less in size and value, but not at all in interest and beauty, were many others that might be named if time permitted. No other forest so rich in species and individuals of commercially important and esthetically interesting trees has ever existed elsewhere in the world. And the pity of it all is that the pioneers of those days never realized what a wonderful asset they had in their great forests. They regarded the forest simply as a source of supply for firewood and the small amount of logs and lumber they needed for buildings, fences and the like, and as something that must be got rid of as soon as possible in the interests of agricultural development.

I have seen many a barn built largely, if not wholly, of black walnut logs; and I later saw some of those same barns and stables torn down and the walnut logs hauled away to the sawmill to be converted into high-priced lumber. On my own father's farm and on many others in the same county, there were thousands of walnut rails in the Virginia worm fences with which the farms and fields of those days were enclosed. In the early seventies, black walnut became so valuable that even the stumps were dug out and shipped away to furniture manufacturers.

The wastefulness in clearing the land was almost beyond belief. Little or no effort was made to save any of the timber except that needed for immediate use. When a piece of land was to be cleared, all the trees were first girdled thus creating a deadening. Then the trees of whatever kind were felled or burnt down, after which the trunks were cut or burnt ("niggered off") into logs of lengths for convenient handling. With teams of horses or oxen, these logs were then snaked around and piled into great log-heaps, four logs on the ground constituting the bottom layer, three on top of these, two on top of them, and finally one at the top. Each log-heap would thus consist of 10 logs, with small limbs, chunks and trash filling the interstices to serve as kindling when the heaps were to be burned. So heavy and dense was the forest that there would be scores of these great heaps on every acre, each heap made

up of logs of the very finest quality whose value to-day would be many times that of the land on which they grew.

The bringing of the land under cultivation was essential to the development of the country. This, of course, necessitated the removal of the forest; heavy forests and corn-fields can not thrive on the same ground at the same time. Nevertheless, the methods were most wasteful, but a valuable lesson can be learned therefrom. Many of the important forestry and agricultural problems that confront us to-day could have been avoided or never would have arisen, if the pioneers could have foreseen the results of their wasteful methods.

That there are many very serious problems is well known to every one who has given the matter any attention. According to the U. S. Forest Service, three fifths of our primeval forests are gone, and the timber remaining is being consumed four times faster than it is being replaced. Several of our principal forest regions are already completely exhausted as large producers of wood products. The injury is felt through the process of regional exhaustion, compelling recourse to more distant and less accessible regions, with the inevitable increase in cost of production, higher freight rates, and greater cost to the consumer.

While the depletion of our forests for legitimate ends has been great, it is the devastation of the forests that has been most serious. The Forest Service tells us there are 326 millions acres of cut over timberlands in the United States. On 81 million acres there is practically no forest growth, and this is the result of forest fires and methods of cutting which destroy or prevent new timber growth. There were in 1919, 27,000 recorded forest fires which burned over 8 million acres. A large additional acreage is burned each year of which there is no record. The area of idle land is being increased 3 to 4 million acres annually as the cutting and the burning of the forests continue. The Forest Service estimates the forest land in the United States not required for any other economic use at 463 million acres, an area that would provide an ample supply of wood if kept productive. Depletion has resulted not from using our timber resources, but from a failure to use our timber-growing lands. The real solution of the timber problem is to grow new forests on the cut-over and the burnt-over ground and protect the forests we still have. There must be a concerted effort on the part of the Federal Government, the states and private owners to stop the devastation of our remaining forests and to put our idle forest lands at work growing timber. As the Forest Service well says, it is inconceivable that we should go on using up our forests without making provision for growing new to replace the

old. The policy should be to maintain timber production on somewhat the same footing as in Scandinavia and France; this should become an established national policy and practice.

The national forests contain several million acres of forest land so severely burned over that it can not be restored without replanting. To restore this land to timber production is an immediate Federal responsibility. Tree-planting is most urgent on denuded watersheds from which water is obtained for power, irrigation, or municipal use.

The cutting off of the forests, but more particularly the undergrowth, has been far-reaching in its disastrous results. The effect upon the animal life of the forests themselves has been marked indeed. Many species of mammals, birds, reptiles and amphibians that found a congenial home in the heavy forests of Indiana and other upper Mississippi Valley states 50 years ago are now rarely or never seen; many of them are now extinct in those regions. Many species have disappeared not because of overhunting but chiefly because of the destruction of the forest cover which was essential to their protection from their various enemies and to their habits of life.

Another deplorable result is that upon the streams of the country. While the removal of the forest cover has probably had no appreciable effect upon the rainfall, it has had a very decided effect upon the run-off. With the forest cover the rain was held by the underbrush until much of it soaked into the ground and the run-off was slow and gradual. The streams therefore had a relatively even flow throughout the year. Now, with the forest cover gone and the land under cultivation, the run-off is rapid, and the streams are very uneven in their volume; raging torrents at times, often spreading beyond the banks after heavy rains, and in the dryer season reduced to series of stagnant pools. And what a change in the beauty of the stream! Then a beautiful, stately flowing stream of clear, cool, pure water, the banks heavily wooded and with underbrush of many interesting shrubs, and greensward here and there, and the water teeming with fishes of many kinds; now at times merely a sluggish, weed-choked thing as devoid of beauty as it is of fish.

Fortunately, it is still possible greatly to improve these streams and bring them back to something of the beauty of earlier days. This can be done by reserving from cultivation a narrow strip of ground along each side of the stream and planting it with perennial plants, shrubs, bushes, vines and trees that will hold the immediate banks of the stream in place and at the same time check the run-off, conserve the moisture, shade the stream, and increase the beauty

of the stream amazingly. This strip can be any width, the wider the better of course, but it ought to be at least 30 yards.

A little attention of this kind will greatly increase the stability and beauty of the stream; it will also be helpful to the fish life of the stream by giving the fish more protection, shade and food. It will be of benefit to the farmers and others along the stream in that it will protect their land from overflow and from destructive erosion.

Another regrettable result of the cutting of the forest and the undergrowth and the draining of the marshlands and the small woodland ponds, is the extermination of many species of the native flora. Among such species that were formerly more or less abundant in the upper Mississippi Valley that may be mentioned are the Wild Red Plum (*Prunus americana*), the Wild Cherry (*Prunus serotina*), Black Haw (*Viburnum prunifolium*), Red Haw (*Cratægus pyrifolia*), Pawpaw (*Asimina triloba*), Leatherwood (*Dirca palustris*), Kentucky Coffee-tree (*Gymnocladus canadensis*), Spice-bush (*Benzoin æstivale*), and various species of orchids, particularly the showy Ladies'-Slipper (*Cypripedium reginæ*). These interesting and beautiful species that added so much of grace and beauty and charm to the virgin forest are now rare indeed, and in some localities entirely extinct. And the regret is all the greater because of the fact that every one of them could have been preserved in considerable abundance if only a little foresight and care had been shown.

Effect of Deforestation upon the Fishes of Our Streams

The effect upon the streams of the cutting away of the forests has been very great, as already pointed out, and it has been equally great upon the fishes of the streams. In order that a stream may support a large and varied fish-fauna it must be somewhat uniform and constant in its character. A stream which at one time is a raging torrent and at another season a series of isolated stagnant pools, does not permit the development and maintenance of a fish-fauna rich in species or individuals. This fact may be readily appreciated if we compare a typical Mississippi Valley creek or river with any typical stream in California where all the streams are subject to great extremes. In almost any small stream in Indiana, there may be found not fewer than 30 to 40 kinds of fishes, a greater number than occurs in all the streams of California or Utah. But the Mississippi Valley streams are rapidly becoming in this respect like those of California—streams of unstable and extreme conditions, and fish-life is decreasing correspondingly. The food and game species, of which there were a score or more originally, are now very scarce. Some of them have entirely disappeared, while others are so rare as to afford little or no sport for the angler.

The United States Forest Service and the National Parks Service in their administration of the National Forests and the National Parks respectively are to-day the most efficient and most effective forces working for the conservation of the forests, the water supply and the natural scenic and esthetic beauty of our country. However, the tendency of the National Parks Service to graft on to some of the National Parks various Coney Island alleged attractions is deplored. National parks should be maintained as *natural* parks and not be marred by artificiality of any avoidable kind.

Drainage of Swamps, Ponds and Lakes

Not until recently have we come to realize that the drainage of swamp-lands, marshes, ponds and small lakes may be fraught with great danger to certain species of animals and plants of economic importance, and that the results are often harmful rather than beneficial to agriculture. A writer (A. G. Reywall), in a recent issue of the Bulletin of the American Game Protective Association, asserts that the havoc wrought in some sections by drainage projects has been so great as to arouse indignation and resentment among people who realize that such areas have important functions in relation to agriculture and the general public welfare. The assumption that the area which it is proposed to drain will prove valuable agricultural land is not always warranted. This writer says:

> The rivers of the country, with their small tributaries, are the natural surface channels for carrying off surplus rainwater. A part of this water works through porous strata to varying depths and is discharged at the surface through springs which are the natural outlets of underground drainage. Small lakes and marsh areas are undoubtedly the fountain heads of great numbers of springs and wells which are so essential to the welfare of the community. These lake and marsh areas also act as great check-basins or natural reservoirs in which are held back enormous quantities of water resulting from heavy rains and rapidly melting snow, allowing it to flow off gradually and thus effectively lessening the danger of floods.

The whole country has been appalled by reports of disastrous floods in which great numbers of lives were lost and millions of dollars' worth of property destroyed. (As I write, the daily papers are telling of great floods in the Mississippi which have rendered more than 75,000 people homeless and destroyed millions of dollars' worth of property.) The destruction of the forests and the drainage of natural catch-basins, such as marsh areas, ponds and small lakes along the waterways, make such catastrophes inevitable, so that at times of unusual rainfall millions of tons of water sweep down the valleys, leaving fearful devastation behind.

In the State of New York it is now planned to establish numer-

ous great reservoirs to hold back the flood water and to regulate the flow of streams that have their sources in the Adirondacks. It will cost millions of dollars to construct reservoirs to hold back water which could have been conserved naturally had the public interest been safeguarded as was easily possible.

Lake and marsh areas in their natural state have numerous important uses. In the first place, they conserve the run-off and establish a relatively uniform stream-flow, as I have already shown. In the second place, they provide resting, feeding, and breeding places for many species of waterfowl and other species of birds. They also provide appropriate environment for the muskrat and other species of fur-bearing animals. With proper management these marshes will yield annually many thousands of dollars in furs. In one marsh of 4,000 acres, in 1913, over 12,000 muskrats were taken valued at several thousand dollars. This marsh has since been drained, and the muskrats exterminated, but only about 100 acres of the area has been found fit for cultivation.

As a glaring example of serious mistakes in drainage operations, I may call attention to the Kankakee River in northwestern Indiana. This was until recently one of the most famous wildfowl shooting regions in America. The marsh through which the Kankakee flowed was some 50 miles long and five to 10 miles wide. Wild ducks and wild geese in enormous numbers annually visited these marshes, some to nest and rear their young, others to rest and feed while on their spring and fall migrations. Muskrats, mink, and other fur-bearers also were there in abundance, and the waters teemed with the finest of food and game fishes.

Recently these marshes have been drained and it has developed that the whole marsh area is sand with a coating of vegetable matter too thin to make a soil of any fertility. Several acres that were sown to rye produced absolutely nothing, and it is now generally recognized that nothing can be grown on this land.

Hundreds of thousands of dollars almost absolutely wasted in draining land which was found to possess very little value for agricultural purposes, and which will probably have to be irrigated at great expense to make it of any considerable value for any purpose. And we now have, or will have, a barren sand-dune region non-productive in any useful way, in place of a region which, before destroyed by short-sighted man, was one of the richest in America in wild fowl, fur-bearing animals and food and game fishes, to say nothing of its esthetic and recreational value.

This deplorable result could have been avoided if a careful soil-survey of the region had been made before deciding to drain the Kankakee marshes.

The State of Minnesota had a very similar experience, but a law has now been enacted to prevent any repetition of such mistakes by requiring the approval of the State Conservation Commission before any large areas may be drained.

It is frankly admitted, of course, that most of the swampland possesses agricultural value when drained, but much of it will have little or no such value. The point I wish to make is this: swamp lands, ponds and small lakes *as such* have uses and values that must not be ignored. I have noted that a proposition has been made recently to drain practically all of the thousands of small lakes in Wisconsin. Should this be done there will probably be more corn, cabbage and hogs in Wisconsin than now, but there will be less of beauty and the appreciation thereof.

Federal Protection of Migratory Birds

Researches by the Bureau of Biological Survey have demonstrated the importance to agriculture of our migratory birds. That insectivorous birds annually save millions of dollars to the farmer by destroying insects injurious to crops is no longer questioned. That millions of dollars of damage have been done to our forests by insects formerly kept under control by insectivorous birds is also well known. The esthetic value of our native birds must not be forgotten—the inspiration and stimulus which they give to the moral sense, the charm and beauty they give to nature and which enter so largely into the life of the people—these are values that can not be overestimated.

It is a great pleasure to call attention at this time to one illustration of intelligent appreciation of the value of our birds. If you will go down near the Temple here in Salt Lake City you will find a graceful Doric column 15 feet high. On the top of the column rests a granite sphere on which two gulls are in the act of lighting. If you read the inscription on the base you will learn that, in the spring of 1848, a terrible plague of crickets threatened total destruction to the growing crops which the Mormons had planted. Nothing which the people could do could stop the vast hordes of insects. Just when the situation seemed entirely hopeless, great numbers of gulls came over from their breeding grounds on Hat Island in the Lake and began devouring the crickets. In a short time the millions of crickets were destroyed and the crops were saved. The people, realizing that the gulls saved the day, expressed their gratitude in an unique and beautiful manner. And we have here to-day the

"Sea Gull Monument
Erected in Grateful Remembrance
of the Mercy of God to the
Mormon Pioneers."

Who can claim that the wild birds are not our friends, or that man is not sometimes appreciative!

Not until within recent years have many really effective steps been taken in this country to protect our birds. Only a few of the states had any protective laws whatever. Finally laws began to be enacted regarding game birds, but no attention was paid to the insectivorous and other non-game species. But the laws enacted by the various states were lacking in uniformity. Nearly all permitted spring shooting and market hunting, the open season was very long and the bag limit, if any, was ridiculously large.

The Lacey Law

One of the first Federal laws in the interest of bird protection was the Lacey Law enacted in 1909. The important provisions of this law are the ones regulating the shipment of game in interstate commerce and that regulating the importation of birds and mammals from foreign countries.

Migratory-Bird Law of 1913

Beginning with 1904, various attempts were made to secure Federal legislation for the protection of migratory birds, but it was not until 1913 that any results were secured. In that year the Federal Migratory-Bird Law was enacted. This law gave the Secretary of Agriculture power to fix close seasons during which it would be unlawful to capture or kill migratory birds. One of the most important regulations under this act was that prohibiting spring shooting. This regulation has proved of enormous benefit. The effect was almost instantaneous. Waterfowl and other migratory game birds at once showed decided increase, and many remained to breed where they had not bred for many years.

The question of the constitutionality of this law was raised but before it was passed on by the Supreme Court the law was repealed by the enactment of more effective legislation in 1918.

The Migratory-Bird Treaty

On August 16, 1916, there was concluded at Washington between the United States and Great Britain a migratory-bird treaty for the more adequate protection of the migratory birds that visit the United States and Canada. This convention was ratified and became law December 7, 1916.

The making of this treaty is probably the most important single event that has ever occurred in the movement for the protection of migratory birds. Of a total of 768 species of birds recognized in the last (1910) edition of the A. O. U. Check-list of North American birds, 537 species are protected by this treaty; only about 220

species are not covered by the treaty; it is unfortunate that they, too, could not be properly included. Among those which are protected by the treaty are all the ducks, geese, swans, shore birds, plovers, snipe, cranes, and all migratory insectivorous birds. The treaty provides special protection for 5 years of wood ducks and eider ducks and for 10 years to the band-tailed pigeon, little brown crane and several other species. It makes spring shooting unlawful, and confines hunting to seasonable periods of not exceeding 3½ months for shore birds not given absolute protection, and other migratory game birds.

The Migratory-Bird Treaty Act

Although the treaty does not provide the machinery for its enforcement, it does provide that the High Contracting Powers shall enact the legislation necessary to insure its enforcement. Canada did so August 29, 1917, and the United States did likewise by passing the *Migratory-Bird Treaty Act* which was approved by the President July 3, 1918; and it has been well said that "the enactment of this legislation rounded out the most comprehensive and adequate scheme for the protection of birds ever put into effect."

Under this Act it is unlawful to hunt, capture, kill, possess, sell, purchase, ship or transport at any time or by any means any migratory bird included in the terms of the treaty except as permitted by regulations which the Secretary of Agriculture is authorized to make.

The constitutionality of the treaty and the treaty-act can not be questioned, for the Constitution provides that "all treaties made or which shall be made, * * * shall be the supreme law of the land; and the judges in every state shall be bound thereby, anything in the Constitution or laws of any state to the contrary notwithstanding."

The first regulations under the migratory-bird treaty act were prepared by the Secretary of Agriculture and approved by the President July 31, 1918. Certain amendments were adopted and made effective October 25, 1918.

The regulations are prepared by the Secretary of Agriculture, with the assistance of the Bureau of Biological Survey and an advisory board of 21 members representing all sections of the country. Regulations prepared with the great care which this implies are quite certain to give protection to the birds and at the same time meet the approval of the great body of sportsmen and others interested in bird protection.

The beneficent effects of this treaty were immediate. Reports showing a marked increase in ducks and other migratory game birds are coming in from all over the country. But as the ducks

increase in numbers it becomes increasingly evident that a few things yet remain to be done before these birds will have entirely adequate protection and before the poor man can get that good from the increase which he ought to enjoy. Realizing this, Senator New of Indiana and Congressman Anthony of Kansas have each introduced bills known as The Federal Public Shooting Grounds and Bird Refuge Act.

This is a bill providing for the establishing of shooting grounds for the public, for establishing game refuges and breeding grounds, for protecting migratory birds, and requiring a Federal license to hunt them.

The important things which it is hoped will be accomplished by this bill if enacted into law are the following:

1. To establish refuges or sanctuaries where ducks, geese and other migratory game birds may stop to rest and feed undisturbed when on their way north in the spring and on their return south in the fall, and where any that may be inclined to do so may be induced to stop to breed and rear their young.

2. To provide for issuing a hunting license at the nominal cost of $1.00 to those who wish to hunt wildfowl.

3. To provide public hunting grounds where anyone with a Federal license may hunt.

The necessity for the sanctuaries becomes more and more apparent every day. The draining of the marshlands, ponds and small lakes in many states is rapidly rendering those regions unattractive and unsuited to waterfowl, with the result that the birds pass over without stopping in many places where they formerly tarried for a time in the spring, many of them even remaining to breed, and in the fall going on south without even stopping for a day.

By establishing sanctuaries many birds would tarry in the spring to rest and feed, some would remain to breed, and in the fall, they would again tarry to feed, and the sanctuaries would then become good shooting grounds.

The Biological Survey estimates that at least 5 million people in the United States take out hunting licenses each year. It is believed that at least one million would take out the Federal shooting license. Anyone wishing a license can obtain it at his post-office. About a million dollars would thus be raised to be used as follows:

1. Not less than 45 per cent. for the purchase or rent of suitable land, waters, or land and waters, for use as public shooting grounds and migratory-bird refuges.

2. Not less than 45 per cent. for enforcing the provisions of

the migratory-bird treaty act and the Lacey Act, and for cooperation with local authorities in the protection of migratory birds.

3. Not more than 10 per cent. for expenses connected with issuing licenses, etc.

One of the excellent features of this law, if it becomes a law, is that all expenses connected therewith will be paid out of the fund resulting from the sale of hunting licenses. The expense of enforcing the Lacey Act and the Migratory-Bird Treaty Act will also come out of this fund. Congress will not need to appropriate any money at all.

Another excellent feature is that it will afford the poor man an opportunity to hunt waterfowl. Under present conditions practically all the good shooting grounds are owned or controlled by shooting clubs to which only men of means can afford to belong. The proposed law will give the poor man an equal chance with the rich man. The cost of the license is nominal; anyone who cares to hunt at all can afford to pay $1.00 for a shooting license.

It has been estimated that there are over 60,000,000 acres of government swamp land in the United States, much of which, even if drained, would have little or no agricultural value. Numerous wild fowl sanctuaries and public shooting grounds could be established in these swamp lands which would prove of inestimable benefit to migratory birds and at the same time afford splendid sport to thousands of people who enjoy a few days shooting each season. I understand that there is at the mouth of the Bear River in this state a large area of swamp land all ready to be made into a large refuge, and I further understand that the Governor and the people of Utah are strongly in favor of having this tract made into a Federal bird refuge and public shooting ground.

This is fine. There are doubtless many similar areas in the state, as there are in practically every state in the Union.

With the establishment of sanctuaries and public shooting grounds such as these in various parts of the country, the safety and conservation of our migratory game birds is assured.

Some of our migratory birds do not belong with the waterfowl. The first of these is the passenger pigeon, a species which 100 years ago was found in the eastern United States in incredible millions but which in the last 50 years decreased to total extinction. The last known living individual died September 1, 1914, in the Zoological Park at Cincinnati where it had been in captivity 29 years. The species is now believed extinct. It is barely possible a few individuals remain in some of our more remote heavy forests, but this is highly improbable. If, perchance, any should remain, they will receive absolute protection under the migratory-bird treaty act, and in time the species may be reestablished.

The band-tailed pigeon, a related species, is not rare in several of the Pacific Coast states. It will receive absolute protection for 10 years. At the end of that period, this interesting and beautiful game bird will doubtless be abundant again.

Still another related species is our common turtle dove, a species of wide distribution, common nearly everywhere, but abundant in nearly all our western states. The turtle dove is very tolerant of civilization and thrives well on the farms. To maintain it in safe numbers it is only necessary to have not too long an open season, a bag limit not too large, and to give rigid protection to their nests and eggs.

Very unfortunately, that great group of gallinaceous birds, the wild turkeys, quail, pheasants, grouse, ptarmigan, prairie chickens and sage hens, are not to be classed as migratory birds and therefore do not come under the protection of the migratory-bird treaty. There are about 50 species and subspecies of them, among which are some of the greatest game birds in the world. Many of them occurred in incredible numbers in the early days, while now probably not one is found in anything like its original abundance.

The wild turkey was doubtless the greatest game bird the world has even known. Up to the close of the Civil War this wonderful bird was abundant from Maryland westward to Minnesota and eastern Kansas and south to Florida and Texas and through New Mexico into Arizona. In the Upper Mississippi Valley it was common in all suitable places as late as 1870; in a few favored localities small flocks survived into the early eighties. In certain localities in southern Missouri, Oklahoma, Texas and Florida a few remain to this day; and it is said a few may be seen in Virginia within sight of the dome of the Capitol at Washington. In New Mexico and Arizona considerable numbers still remain.

The nature of the wild turkey is such as apparently makes it intolerant of civilization; it is not necessarily so. While it is a bird that under persecution requires heavy cover, it thrives well in open woods, especially of oak and beech if not too persistently molested. There still remain in many of the states thousands of acres of excellent cover where the species could doubtless maintain itself if once reestablished and proper protective laws and regulations provided.

What I have said regarding the wild turkey can be said of most of the species of gallinaceous birds. Most of them were once vastly more abundant than they now are and many of them must be classed among the vanishing game birds unless something is done soon for their preservation. The ruffed grouse and all the quail,

the prairie chicken and the sage hen, are each, in varying degrees, seriously depleted and in danger of actual extermination. While much has already been done to save the bob-white and other quail, and perhaps a few others, even they are doomed unless a great deal more is done.

The natural cover along the stream courses, on the hillsides, in the glens and dells and in and about the marshes and swamps affords ideal environment for the ruffed grouse. Every effort should be made not only to preserve every existing acre of this cover, but the cover should be improved whenever possible, and new acreage should be added from time to time by encouraging wild growth upon otherwise useless land. On many farms there are small waste areas which, with a little carefully directed neglect, can be converted into copses that would serve admirably for birds of this kind.

Cover that is good for ruffed grouse is also good for the bob-white. Even a very small thicket will furnish ideal cover for a flock of bob-whites. A number of such thickets judiciously located about the farm would do wonders in keeping it well supplied with these birds.

The prairie chicken, like the bob-white, is a species tolerant of civilization. Fields of grain such as wheat and corn are just to their liking and the wastage in the fields would assure an abundant food supply throughout the winter and any periods of food scarcity that might come. All that is necessary is a few waste places on the farm covered with copsy thickets and tall grass.

Of course their nests must be protected; and this leads me to make a plea for the unkempt fence corner, where the grass and weeds are allowed to grow and the briars and brush to run riot over the ground and fence. True, this is not so possible now with our wire fences as it was in the good old days of the picturesque old Virginia stake-and-rider rail fence—more's the pity. Such cover as the fence rows of this kind would afford would prove invaluable to prairie chickens and quail by supplying protection not only to the birds themselves but also to their nests.

The sage hen is one of our most picturesque and most valuable game birds. In size it is inferior only to the wild turkey. On our western sage-brush plains it formerly occurred in countless numbers. Its natural habitat was the almost valueless sage-brush country where agriculture is in most places impossible, although it has a slight value for grazing. And it is this that is exterminating the sage hen. Flocks of sheep ranging over the sage-brush plains during the breeding season of the sage hen are almost certain to destroy every nest which the sheep herders had not already robbed. Regions in which sage hens were common only a few years ago are

now without a single bird. Unless the Federal government and the states take action very soon the sage hen is doomed.

The woodcock is another of our splendid but vanishing game birds. Perhaps no other game bird has been more highly esteemed. Feeding, as it does, almost entirely on angleworms and other food which it obtains by prodding in the soft ground of the borders of ponds, springs and marshes, it is easy to see how disastrous to this bird the draining of our marshlands must inevitably prove to be. Moreover, it is a delicate bird, easily influenced by sudden freezes which make it difficult for it to obtain food.

Much can be done toward saving the woodcock by leaving undrained all marshland, ponds and springy hillsides that are not really needed for agricultural purposes.

The jacksnipe is very similar to the woodcock in its habits, game qualities and danger of extermination, and the measures that would be taken to save the one would apply to the other.

Of the scores of species of our less important game birds I need say little, except that they must not be forgotten and that measures taken to conserve the important species will ordinarily apply to the less important ones as well.

Game Mammals

Excepting perhaps Africa, no other country in the world ever equaled North America in the richness of its game mammals, marvelously rich not only in species and subspecies but also in number of individuals. Of the more than 300 species that might be mentioned, it must suffice to speak of only a few, for the story of former marvelous abundance, wasteful killing without thought for the future, and inevitable extermination or serious depletion applies to all.

The three species of grizzly bears that occupied such a picturesque place in the early history of California are all extinct; it is believed that not a single individual remains alive anywhere to-day. Many of the others, while not actually extinct as species, have been actually exterminated over a large portion of the country over which they originally ranged. Among these are several species of deer, the buffalo, moose, elk, antelope, various bears, foxes and gray squirrels. All that we have left now are isolated pitiful remnants of the vast numbers with which our older people were once so familiar. Many of them are so rare now that we can truthfully say they are, indeed, commercially extinct, and can never be restored.

Of course, it is quite true that serious depletion, even commercial extinction, of some of these species, such as the buffalo, was inevitable. On the other hand, it ought to be possible to reestab-

lish many of these species and bring them back to something like their former abundance. The changes in environment incident to the development of the country agriculturally and otherwise should not necessarily prove fatal to them. Moose, deer, bear, foxes, squirrels, beaver and muskrats could doubtless be maintained indefinitely in large numbers in many parts of their original habitat, if given that protection which can easily be given, and at the same time splendid productive hunting could be had. This would apply to Maine, the Adirondacks and other parts of New York, many parts of Pennsylvania, Michigan, Wisconsin and Minnesota. And the same could no doubt be done in all the states along our northern boundary and in all the Pacific Coast states. The muskrat should still find a congenial home in all parts of the United States east of the Sierras wherever swamp land, marshes, permanent ponds and small lakes are found; provided, always, that such of these favorable localities as can not be made agriculturally valuable are left undisturbed.

It is true that some of our most interesting game animals are predatory, not only upon other wild animals such as deer, antelope, elk and ground-nesting birds, but also are destructive to domestic stock. Among the worst are the wolves, coyotes, Canada lynxes and mountain lions. The United States Bureau of Biological Survey has been waging a very effective campaign against these predatory animals. When the Bureau began its campaign a few years ago it was estimated that these animals were causing a loss of more than $20,000,000 annually. Expert hunters and trappers were employed by the Bureau in cooperation with the states and with other interested agencies with the result that more than 50,000 predatory animals were destroyed in one year. If these animals had not been killed they would have destroyed fully $3,000,000 worth of domestic live stock to say nothing of the great numbers of deer and other valuable game mammals and birds they would have destroyed.

One sheep man wrote to the Survey that its predatory-animal hunters had saved his flocks from the loss of at least 1,000 lambs in one year. There are among predatory animals just as there are among dogs individuals that have acquired the sheep-killing or calf-killing habit, and the expert hunters make special and usually successful efforts to get them. A noted case was that of the notorious Custer wolf in Wyoming, which was believed to have killed $25,000 worth of cattle in a period of seven years. So crafty was this old wolf that he eluded all efforts to capture or kill him in spite of the fact that a bounty of $500 was placed on his head. But last year he met his fate through the skill and marksmanship of a bureau hunter.

Another illustration: a pack of eight wolves that had inflicted losses totaling $20,000 on calves, pigs and sheep about the Arkansas National Forest were all destroyed by a single bureau hunter in a period of three weeks. Still another old renegade wolf reported to have destroyed $6,000 worth of cattle on a single ranch besides making heavy inroads on other ranches, including nine head of yearling cattle in the last six weeks of his life, finally fell a victim to a skillfully placed trap of a bureau hunter.

The California Fish and Game Commission estimates that a mountain lion will kill on an average one deer a week throughout the year, and that there are about 600 lions in the state. At 52 deer each they would kill about 30,000 deer annually, which is about twice the number killed by all hunters in the state. From this it appears that the mountain lion should receive no protection.

Fortunately, the great majority of our important game mammals are not predaceous at all, or in only a slight degree. Fortunately also, some of the species are being conserved fairly well in some parts of their range. This is especially true of the deer.

The federal and state governments have established a number of game preserves, some of them under fence. The principal game animals in these reservations are buffalo, elk and antelope. All are showing satisfactory increase each year, and there is every reason to believe that these herds will continue to thrive.

The outlook for the wild elk, antelope, mountain sheep and mountain goats is not so encouraging.

Of the several species of elk the one commonly known as the California Valley elk or Tule elk is in most serious danger of extermination. This species formerly ranged over the San Joaquin Valley in great numbers. About 50 years ago it was threatened with extermination, but it was saved through the active interest of Henry Miller, head of the great cattle company of Miller & Lux.

In 1914 the only remaining herd of this species ranged over the Buttonwillow ranch of Miller & Lux in Kern County. In that year and in 1915 the California Academy of Sciences with the cooperation of Miller & Lux distributed 150 of these elk to various federal, state and private parks in the state, and it is gratifying to know that in most cases the animals have increased in numbers, and that these nuclei of new herds are doing well.

But the original herd in Kern County is in serious danger. Although it is unlawful to kill any elk in California, the warden service is poor and the animals are not receiving the protection they must have if the herd is to be saved. In my judgment the species is doomed unless more adequate measures for their protection be taken soon.

Probably the best thing to do would be to enclose with suitable

fence not less than 3 or 4 square miles of land in the region they inhabit. It would be easy to do this. A strip of land one mile wide, beginning up toward the foothills where the elk habitually stay and extending down into the valley about four miles so as to include about 300 acres of arable land on which alfalfa can be grown to supply feed in the dry season, is all that is necessary. The sale of surplus males and other animals from time to time to zoological parks, etc., would render the herd self-supporting.

Fur-Bearing Animals

Few of us realize what an asset the various states have in their fur-bearing animals. America's list of fur-bearers is a long one; the total number of species and subspecies whose pelts have considerable commercial value as fur is not fewer than one hundred. Among those of most importance may be mentioned the beaver, otter, fisher, mink, fur seal, sea otter, marten, muskrat, skunk, raccoon, weasel, fox, lynx, bobcat, wolf, coyote, and bear. Several of these are represented in the United States by two or more species or subspecies.

Not until recently were several of these species in much demand, but now the lowly muskrat and the much-despised skunk have come into their own. They are now among the most popular and high-priced furs.

As Dr. Dearborn, of the Bureau of Biological Survey, has well said, the demand for fur has existed since primitive man first sought skins to shield his naked body from the cold. This demand is fundamental and will endure while man inhabits the earth and furs are to be had. Its strength can be judged by the volume of trade it supports.

The fact that many of the fur-bearers are predaceous animals complicates the problem. However valuable the fur of an animal may be, if the habits of that animal be such as render it an enemy of domestic stock or useful game animals, its conservation is not an unmixed blessing. Such animals must therefore receive special treatment. Fortunately, the majority of our fur-bearers are destructive to other useful species or interests only in a small degree or not at all, and it is possible to provide laws and regulations for the conservation and proper utilization that will render their preservation highly desirable.

Some of the more important species are already seriously depleted; some have been even exterminated in many regions where they were formerly abundant. The beaver, marten and mink may be mentioned as examples of this class. Their extermination has been brought about chiefly by excessive trapping and changes in the character of their environment. It is believed that most of

those which have been greatly depleted can be restored and maintained in reasonable abundance if proper laws and regulations be provided for their protection.

The essential principles of the protection of fur-bearing animals are few and easily understood. In the first place, there should be a permanent closed season for a period of years in any region in which the species has become so seriously depleted as to be in danger of extermination. In the second place, no animal should be killed during the breeding season; that is, when its death would mean the starvation of the young; and fur-bearing animals should be killed only when their fur is prime.

Perhaps the most important of these is that relating to unprime skins. It has been estimated that the value of the furs that come to the markets is reduced fully 25 per cent. by the large number of unprime skins. Killing fur-bearers in their breeding season before the family break-up and dispersal in the fall is a wasteful practice. Uniform laws throughout the United States prohibiting traffic in unprime skins should be enacted.

Every trapper or hunter of fur-bearing animals should be required to secure a license good for one year, and he should be required to report at the end of the season the number of animals of each species taken. This would furnish data essential to determining the value and extent of the fur resources of the state and the relative abundance of the different species. Such statistics would inspire people with a desire and determination to make fur a regular and valuable farm and forest crop.

Under natural conditions or such as can be easily maintained, one or more species of fur bearers may be found in some numbers on many of the farms of the country. Hunting or trapping such animals is a recreation, sport or avocation that appeals strongly to most country boys. If they do their trapping intelligently, they will not only profit greatly by the sport it affords but will also add materially to the income from the farm.

Fur-Farming

Recently the possibilities of fur-farming have begun to attract wide attention.

Figures compiled by the Bureau of Biological Survey show that there are fur farms in at least 25 states. There are about 500 ranchers raising silver foxes, with 12,000 to 15,000 foxes in captivity.

Other species on the fur-farms are skunk, raccoon, mink, opossum, marten, muskrat, squirrel and beaver. The business, when intelligently conducted, is a fascinating and profitable one and can be carried on successfully in almost any of the states.

The state agricultural colleges and experiment stations, and state game and conservation commissions should encourage fur-farming. The United States Bureau of Biological Survey will be glad to give directions and suggestions as to the methods of fur-farming that one must follow to insure success.

In those parts of the country where there are small lakes or ponds surrounded by marshland opportunities for fur-farming are excellent. Usually in each marsh there will be found from a few to many muskrats. With proper care and management, the number can usually be greatly increased and maintained, at the same time permitting a considerable annual catch. And now that the muskrat is so popular as a fur, under the trade name of "Paris Seal," muskrat farming will prove a very profitable side issue on the farm.

Marine Mammals

There remains one important natural resource in which this country is vitally interested, the conservation of which has received practically no attention; and this appears all the more astonishing when we realize that in this natural resource are found not only the largest animals in the world but a number of the most valuable. I refer to the marine mammals—the whales, fur seals, walrus, sea lions, sea otters, porpoises, the elephant seal and other species whose home is in the sea. And it is a curious fact that we know less about these great and interesting animals of the sea than we do of any other group of useful animals.

We know a good deal about the Alaska fur seal; a little is known about the Russian fur seal and the Japanese fur seal, but scarcely anything about the several species in southern waters.

Some years ago, a species of fur seal was not uncommon about the islands off the coast of California and Lower California. In the early part of the last century it was very abundant on the Farallons just off the Golden Gate. One party that visited those islands in 1808 took in two seasons 130,000 fur seals and many sea otters. Another party took 33,740 fur seals in 1810 and 39,555 in 1811. The catch in four years was more than 200,000. It has been thought this species became extinct about 30 years ago. However, the capture of a living specimen in March (1922) near San Diego shows that it is not yet extinct; it further emphasizes our lack of knowledge of the distribution and abundance of our marine mammals. It also suggests the possibility of reestablishing fur-seal rookeries on the Farallons and other islands off the coast of California and Mexico. What a fine achievement that would be!

We know only in a general way what species of marine mammals there really are in the North Pacific; but it is safe to say the mammalian fauna of the Pacific is the richest in the world. There

are probably not fewer than 50 species in the North Pacific and the total number in the entire Pacific is doubtless much greater; but we do not really know. In the North Pacific we may recognize 14 kinds of whales, 12 porpoises, killers, dolphins, etc., one bear, two sea otters, four fur seals, and a dozen hair seals, harbor seals and sea lions.

With few exceptions practically nothing is definitely and authoritatively known of the life history of these animals. Their food and feeding habits, distribution, migrations, breeding seasons and places—these are but a few of the many things in the life history of these species about which we would like to know and which we must know before final measures for their protection can be intelligently formulated.

The commercial fisheries of the North Pacific can be properly understood and regulated only in the light of pretty full knowledge of the whales, seals and other marine mammals. We must know just what relation the whales, sea lions, harbor seals and porpoises sustain to the salmon, sardine, herring, cod and other food-fishes of our coast. The relation of the California sea lion to the salmon fisheries has long been a matter of dispute. Conclusive and convincing study of the question has never been made, and no one is in a position to say just what laws and regulations should be enacted regarding those species. The same is true of the whales. Our knowledge of their abundance, distribution and feeding habits is very incomplete.

Not long ago the Moss Landing Whaling Station of the California Sea Products Company reported they had found in the stomach of one humpback whale 1,500 to 3,000 pounds of sardines, besides a miscellaneous lot of smelt, anchovies, shrimp and squid! In the stomach of a sperm whale were found a 10-foot shark, a piece of fur-seal skin and a bunch of fishhooks! Some time ago two killer-whales or Orcas were examined at the Pribilof Islands; the stomach of one contained 18 fur seals, the other 24. At current prices of fur-seal skins those meals cost about $1,000 to $1,500 each!

These illustrations are sufficient to show that these species bear a very important relation to the sardine, fur seal and other commercial fisheries. And they further show the necessity of a thorough study of the relation of these and other marine mammals to the fisheries.

The Moss Landing Whaling Station furnishes exceptional facilities for a study of the whales. The California Sea Products Company which owns and operates this station has very kindly kept certain records, at the writer's suggestion, during the past four years. These records include the following data for each

whale taken: species, sex, length, weight, stomach contents, date when taken, place where taken, and size of embryo, if any.

The total number of whales taken by this company on the coast of California from January 16, 1919, to May 3, 1922, was 832. Seven different species were represented, as follows: bottlenose 1, sei 1, California gray 1, sperm 5, sulphur-bottom 5, finback 33, and humpback 781; total 832.

These figures are of value in that they show the species of whales that now occur on the coast of California and the relative abundance of the different species. It is seen that only one—the humpback—is at all common. The scarcity of the others is significant; indeed, all but the humpback are already commercially extinct. Only the humpback remains in sufficient abundance to justify the establishment of a whale fishery on this coast.

In 1853 Captain Scammon estimated that fully 30,000 California gray whales visited the California coast annually. The small catch of that species shows clearly that it has been almost exterminated on the California coast. It is evident that the humpback whale also will soon be as seriously depleted unless effective measures be taken soon for its protection.

While the whales are the largest animals in the Pacific, they are by no means the only ones that are in grave danger of extermination and that need protection.

In the early days the southern sea otter was common on the California coast and about the islands off the coast of Lower California. According to old Spanish records 9,729 sea otters had been taken on the California coast prior to 1790. The O'Cain expedition in 1803-4 took 1,100, the Winship expedition took 5,000 in 1805-6, and a party under a man named Campbell took 1,230, all on the California coast. From these figures it is evident that the sea otter was formerly very abundant on the California coast and that the environment was a very favorable one. It seems that it should be possible to reestablish the sea otter in those waters. While none has been seen for several years, there is good reason to believe a few still survive.

The Guadalupe fur seal was at one time common about certain islands off Lower California, but none was seen since 1892 until in March of this year, when one was captured near San Diego. This would indicate that there still exists a remnant of a herd that can again be built into one of commercial importance.

Up to a few years ago the great elephant seal existed in considerable numbers at Guadalupe Island off Lower California. It is now almost extinct; only prompt action can save it. On the same coast and in the Gulf of California sea turtles were very abundant not long ago; now they are said to be very rare.

Several other species threatened with early extermination could be named, but these must suffice.

The Alaskan, Russian and Japanese fur-seal herds are now fairly safe, thanks to the International Fur-seal Treaty entered into in 1911 by the United States, Great Britain, Russia and Japan. The northern sea otter is also protected by the same treaty. While that treaty has some serious defects it is believed they can be corrected in 1926 when an opportunity to do so will be afforded. But this treaty, unfortunately, does not cover whales, walrus, sea lions, southern sea otter, elephant seal or any of the southern fur seals.

It is perfectly lawful for anybody to kill any of these animals anywhere on the high seas. No country has jurisdiction beyond the 3-mile limit. Only by international agreement can they receive the protection necessary for their preservation and conservation.

The United States should take the initiative in bringing about an international treaty for the protection of the marine mammals of the Pacific. The principal countries concerned are the United States, Japan, China, Russia, Great Britain, Mexico and Chile, but every country at all interested in the Pacific should be invited to join in the treaty.

At the meeting of this association held in Berkeley last year a "Committee on the Conservation of Marine Life of the Pacific" was appointed. This committee is now functioning under the Committee on Pacific Investigations of the Division of Foreign Relations of the National Research Council. The committee is endeavoring to develop an interest on the part of the public in conservation of our natural resources, particularly those of the sea. It is endeavoring to interest the zoologists of the countries bordering on the Pacific in the wonderful animal life of that great ocean. It is making investigations and assembling data regarding the former abundance of various species, their present condition, and the causes which brought about the change.

In its efforts toward creating a strong public sentiment for conservation, the committee is trying to interest boards of trade, chambers of commerce, fish commissions, scientific societies, newspapers, women's clubs, and officials of educational institutions including colleges, normal schools, and public schools. It hopes to make use of the public press and public lectures that the people may learn something about the wonderful resources of the sea which we, through ignorance, indifference and greed, are permitting to be seriously if not fatally depleted. The committee plans to form an association or organization to be known by some such name as "The Associated Societies for the Conservation of Marine Life of the Pacific," and it is hoped to bring into this association as many as possible of the naturalists, educational institutions,

chambers of commerce, boards of trade, fish and game commissions, fishery companies and other interested units found in the various countries bordering on the Pacific.

It is hoped that public interest in the conservation problem of the Pacific will in the near future be developed to such an extent as will result in an international treaty broad enough in its scope to cover not only all the marine mammals but also the fishes, birds, and reptiles of the Pacific Ocean.

That our game mammals and birds, our fur-bearing animals and our marine mammals are among our most valuable natural resources is not fully realized by many of us. A few figures, however, will readily convince us that we have in these animals natural resources almost fabulous in their money value. Take for example the deer: the number of deer killed in 1915 by hunters in 36 states was 75,000. At 150 pounds each these would weigh 11,250,000 pounds, worth 20 cents a pound, or $2,250,000. It is claimed that the annual kill of deer in the entire United States could safely be put at 100,000, worth $3,000.000. Rabbits are a very valuable food asset. In 1918, 465,000 were killed in the State of New York alone. In 1919, 2,719,879 were killed in Pennsylvania. In 1920, 293,665 were killed in Virginia. At 20 cents apiece (a very conservative estimate) these rabbits had a money value of $695,710, which is no small item in the food supply of the country. And this embraces the catch in only three states. In the whole United States it must have been many times as great.

Now let us consider the game birds. In 1920 hunters in Minnesota killed 2,083,991 ducks, geese and other game birds, worth at least $1,000,000. In the same year there were killed in Virginia 187,582 quail, pheasants, turkeys, doves and woodcock worth more than $110,000. The take of game animals in the same period was valued at $350,000, while in New York the game mammals and birds taken in the same period numbered 1,526,960 valued at $3,239,277. From these figures it is believed that the game mammals, fur-bearing animals, and game birds of the United States yield to our people not less than the stupendous amount of $100,000,000 annually. Surely the conservation of such valuable resources as these is well worth while.

I should like to say something about the fisheries and the fur seal, those wonderful resources in which I have been most interested for many years, but time does not permit.

I can only say that they, too, must receive our most thoughtful and serious consideration if they are to be rehabilitated and maintained in anything like their former productiveness. No nation can grow populous and great and long survive which, through lack of vision, continues to destroy those very resources which have made it great.

SOME THOUGHTS ON IMMIGRATION RESTRICTION

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A SURVEY of American literature on immigration during the past twenty-five years emphasizes certain general tendencies. There has been a singular failure on the part of many writers to appreciate the larger, more fundamental, more permanent relations of the problem. The immediate, the temporary, the individual aspects have been unduly emphasized. There have, of course, been outstanding exceptions to this broad statement: men of vision, who have labored earnestly to bring before their fellow-countrymen the far-reaching racial, economic, political and social relations of alien immigration. But, in the main, most of what has been written has not been constructive in the best sense of that term. In view of the present widespread discussion of immigration in our magazines, in Congress and in our daily newspapers, the writer of the present article has thought it worth while to consider briefly some of these larger aspects of the problem as they present themselves to his mind. There is danger that the public will be diverted from a really serious consideration of the question as a whole by having its attention constantly directed to the stories of individual hardship—mostly fictitious or exaggerated—which are being so assiduously fed to the daily press by influences which are opposed to all restriction.

AMERICA'S "TRADITIONAL" IMMIGRATION POLICY

In any discussion of immigration problems reference is sure to be made to our so-called "traditional policy" of providing an asylum and a haven of refuge for the poor and the oppressed of every land. There is a fundamental error in the popular conception of this "tradition."

The desire that there should be some restriction has existed from the very foundation of our Republic. Washington questioned the advisability of immigration except of certain skilled mechanics. Jefferson expressed the wish that there were an ocean of fire between this country and Europe, so that it might be impossible for any more immigrants to come here. The Hartford Convention, in 1812, proclaimed that "the stock population of these states is

amply sufficient to render this nation in due time sufficiently great and powerful." In spite of these early distinctly restrictionist views, it was, nevertheless, for generations a national ideal that America should be an asylum and a refuge. But it must be remembered that immigration was then welcomed and encouraged because it was regarded as a source of national strength. The noble ideal of a refuge, open to all, had its roots in economic conditions far more than in any generous spirit of world philanthropy. The country was very sparsely settled. There was an abundance of free land. Labor was scarce. The number of immigrants was small. Nearly all of them were sturdy pioneers, of essentially homogeneous and readily assimilated stocks.

In time this ideal inevitably came into conflict with changing economic and social conditions. In the face of cold, hard, present-day facts it has had to be abandoned. These facts are that the supply of public lands is exhausted; that acute labor problems have arisen; that immigration has increased enormously and fundamentally changed its character; that our cities are congested with aliens; that we have failed to assimilate them, and that large numbers of mentally and physically unfit have come to our shores. Our so-called traditional policy began, in fact, to be abandoned almost fifty years ago, when Congress first put up the bars against certain classes of economically and morally undesirable aliens. It is now obvious that our "asylum" has become crowded with alien insane and alien feeble-minded; that our "refuge" is a penitentiary well filled with alien paupers and criminals.

The un-American policy is not restriction but indiscriminate hospitality to immigrants. It is un-American for us to permit any such influx of alien immigrants as will make the process of assimilation and amalgamation of our foreign population any more difficult than it already is. It is for the best interests of the alien as well as of America that our immigrants should be numerically restricted and wisely and carefully selected.

Our policy of admitting freely practically all who have wished to come has not only complicated our own problems, but has not helped the introduction of political, social, economic and educational reforms abroad. Our idealists tell us that the "cream" and the "pick" of Europe has been coming here because it is discontented at home; because it wants political and religious and economic liberty; because it wants education, and better living conditions, and democratic institutions. Have we in any way really helped the progress of these reforms by keeping the safety-valve of practically unlimited immigration open? By allowing the discontented millions of Europe and of Asia to come here now, are we

likely to hasten, or to delay, the coming of political and social reforms in Armenia, in Russia, in Turkey? Our duty as Americans, interested in the world-wide progress of education, of religious liberty, of democratic institutions, is not only to preserve our own institutions intact, but also to help the discontented millions of Europe and of Asia to shoulder their own responsibilities at home; to work out there, for themselves, what our own forefathers worked out here, for us and for our children. Are men and women who are now leaving their own countries and their own problems behind, likely to be of any real assistance to us in the maintenance and development of American institutions?

Fallacies of the "Melting-Pot" Idea

"Never shall ye make the crab walk straight. Never shall ye make the sea urchin smooth." Thus, many centuries ago, Aristophanes set forth his view of the fallacy of the "Melting Pot." We have been proceeding on the theory that the United States could, in the great American melting pot, crystallize into a new, homogeneous race, better and finer than has ever been known, the millions of aliens, of all nations, habits and languages, who have flocked to us from every quarter of the globe. We have thought that sending the alien children to school, teaching them English, giving them flag drills, and letting them recite the Gettysburg Address and read the Declaration of Independence, would make Americans of them almost overnight. Yet the laws which rule in the world of the lower animals obtain equally in the case of man. We can not make a heavy draught-horse into a trotter by keeping him in a racing stable. Nor can we make a race true to the old American type by any process of Americanization, essential as that undertaking is for creating better citizenship. It is distinctly the trend of modern biological discovery that heredity is, on the whole, far more important than environment in determining not only the physical but also the mental characteristics of man. Dr. Henry Fairfield Osborn, in an address before the recent International Eugenics Congress said: "We are slowly awakening to the consciousness that education and environment do not fundamentally alter racial values. . . . The true spirit of American democracy, that all men are born with equal rights and duties, has been confused with the political sophistry that all men are born with equal character and ability to govern themselves and others, and with the educational sophistry that education and environment will offset the handicap of ancestry."

What goes into the melting pot determines what shall come out of it. If we put into it sound, sturdy stock; akin to the pioneer breed which first peopled this country and founded its institutions;

if these new stocks are not only sound physically but alert mentally, then we shall develop a new race here, worthy to carry on the ideals and traditions of the founders of this country. But if the material fed into the melting pot is a polyglot assortment of nationalities, physically, mentally and morally below par, then there can be no hope of producing anything but an inferior race.

It is often said that each of the different alien peoples coming here has something to contribute to American civilization; that we shall be the gainers, not the losers, in the long run. That many of our immigrants have something to contribute is true. But we want desirable additions to, and not inferior substitutes for the good we already have. There is nothing in biological discovery or principles which would lead us to hope that only the virtues of the races which are going to make up the future American will survive, and the vices be eliminated. In fact, the vices and the undesirable qualities are just as likely to survive as the virtues. We have, of late years, not been getting the best of Europe.

The immigration question is usually discussed from its economic, its political, its industrial sides. Yet its racial aspects are infinitely more important. The character of the future American race is to be determined by the aliens who are landing on our shores day by day. As Dr. Lothrop Stoddard has stated the case, "the admission of aliens should, indeed, be regarded just as solemnly as the begetting of our own children, for the racial effect is essentially the same." And Major General Leonard Wood summed up the Melting Pot problem clearly and briefly when he said: "The American cement has about all the sand it will stand."

The statement of Aristophanes, above quoted, finds a parallel in the words of one of the best-known of modern writers on heredity, Professor Karl Pearson. "You can not change the leopard's spots, and you can not change bad stock to good. You may dilute it; spread it over a wide area, spoiling good stock, but until it ceases to multiply it will not cease to be."

Immigration and the Need of Labor

A stock argument against immigration restriction is the "need of labor." Many, if not most, of the evils which have resulted from the enormous and practically unselected immigration of the past twenty-five years have been due to the reckless greed for "cheap labor" on the part of large industrial, railroad and mining "interests" in this country. These "interests" have set pocket book above patriotism. They have been regardless of every consideration other than that of speeding-up their factories, their railroad construction and their mine output. To those who realize that cheap foreign labor is often so cheap that it is dear at any

price; that it is usually, in the long run, socially and politically very expensive; that a tremendously rapid development of our country is by no means altogether desirable, and that every immigrant is to play a part in the formation of the future American race, this matter of cheap alien labor presents wholly different aspects.

As Dr. Madison Grant has recently said, if the only object sought is a quick development of our country; if within a generation we want to exploit all our natural resources; to have huge industrial plants at every turn; to build railroads and highways paralleling and criss-crossing each other in a fine-meshed network, then it is doubtless true that a huge supply of cheap foreign labor will be needed. But is this "need of labor" any adequate reason for admitting aliens by the wholesale, without giving any thought to the question whether they are going to be intelligent, law-abiding, constructive citizens? Any industrial triumph; any phenomenal exploitation of our resources; any remarkable accomplishment in the development of transportation which can be achieved only by means of such labor, will eventually be paid for with a price which will involve political and racial disaster.

The vital question is not how fast can we possibly develop this country, but how best can we develop it. We have been assuming that we could safely admit as many immigrants as can be industrially assimilated; as can, somehow or other, scrape up a living here, or, failing that, can be supported by our charitable organizations. But the real questions are: how many can be politically assimilated; how many can be thoroughly Americanized; and what sort of contribution are they likely to make in the development of our future race? The need of more "hands" to do our labor has been dinned into our ears for decades. "Hands across the sea" are the cheapest, so we have been importing them. Let us not forget that we are importing not "hands" alone but bodies and hereditary tendencies also. It is of vital consequence that the quality of these human beings who come to us from other lands should be of the best, so that they shall not injure but improve our stock. Every day that passes witnesses the landing on our shores of aliens whose coming here is absolutely certain to result in a deterioration of the mental and physical standards of the American race of the future.

There are doubtless many who, like the present writer, are not employers of labor, nor daily wage-earners, nor economists, who may, nevertheless, have certain views on this matter which are entitled to consideration. To those who belong to this group the question arises whether any American industry which can not

prosper without a constant supply of cheap foreign labor is really worth preserving in a country which boasts of the high standards of living of its wage-earners and the high character of its citizenship. For any indispensable work which can be done by relatively low-grade and unintelligent men and women there would be a sufficient supply of labor from the natural increase of those who are already residents of this country. Somewhat higher wages would probably have to be paid in certain cases and for a while, but if the price were too high, American inventive ingenuity would very soon solve the difficulty by means of labor-saving machinery. If a "cheap" man becomes too expensive, machinery inevitably takes his place. It would doubtless be far better and safer for the United States to enter upon a period of slower industrial development, with a labor supply recruited from the loins of its own population and from a carefully sifted and limited foreign immigration, than to drive ahead at its previous speed, with its industrial development stimulated by means which will inevitably result in a lowering of our political and racial standards. Furthermore, it is generally agreed even among anti-restrictionists that the majority of aliens now coming in are unfitted, by training or temperament, for common labor.

The late General Francis A. Walker laid emphasis upon one point which deserves mention, again and again, when the argument is made that we need cheap labor to do certain disagreeable and degrading jobs. No job, said General Walker, is too cheap or too mean for a self-respecting man to do. In the early days all our work was done by Americans, and none of it was neglected on the ground that it was degrading. The same thing is true in many of our country districts to-day, wherever there are native Americans who depend on themselves to do the necessary daily task. It was not until ignorant and unskilled aliens began to come in in considerable numbers, and took up the lower grades of unskilled labor, that these jobs began to be considered beneath the dignity of self-respecting Americans.

Will Distribution of Immigrants Solve Our Difficulties?

Anti-restrictionists wilfully, and some restrictionists ignorantly, argue that a better distribution of our immigrants will solve our problem of assimilation. The difficulty, it is claimed, is not that there are too many aliens but that they do not go to the right places. Our arriving immigrants naturally flock to the large cities, where their compatriots are already congregated, and where rough construction work and odd jobs are more easily found. Much is said about the need of farm labor, yet even if many thousands of aliens were actually distributed where there is a lack of

farm laborers, the majority of them would not be effective. What our great farming districts need is highly intelligent labor, skilled in American farming methods, and able to manage modern agricultural machinery. Ignorant, unskilled, non-English-speaking foreigners, who know little beyond the use of a primitive hoe, are not wanted.

It is significant that at the last annual session of the Farmers' National Congress, with delegates from over thirty states in attendance, the following resolution was unanimously adopted:

> *Resolved*, That we are unalterably opposed to the proposed diversion and distribution of aliens over the farming districts until immigration is rigidly restricted, numerically or otherwise.

In a recent issue of the *Southern Textile Bulletin*, emphatic protest was made against the importation of foreign textile labor into the South. "We do not counsel violence," the paper says, "but if violence is necessary to rid our mills of these foreigners, it were better to have violence now than to see our operatives forced to live and work alongside a disreputable foreign element."

In his able and timely article, "Throwing away our Birthright," in the *North American Review* for February, 1922, Mr. William Roscoe Thayer states that "all attempts to distribute immigrants according to certain localities have thus far failed." The case is cited of a serious effort made some twenty years ago by the Italian Ambassador to the United States, Baron Mayor des Planches, to plant colonies of Italians in the Southern States. The scheme was unsuccessful. Two other specific instances of attempted distribution come to mind. One is the case of the importation of a shipload of picked immigrants by the State of South Carolina, every one of whom had disappeared within a few months. The other is that of the more recent importation of Mexican laborers into the Southwest during the war. These aliens were admitted under special conditions to do certain agricultural work, and were later to return to their own country. Most of these men also disappeared and could not be sent home again. In other words, while it may in certain cases be possible to distribute aliens, the matter of keeping them where they are sent is a wholly different matter. In the final analysis, on however large a scale it may be carried out, and however effective it may seem to be, distribution, as President Roosevelt put it in one of his messages to Congress, "is a palliative, not a cure." It can never solve our immigration problems.

SOCIAL LIFE AMONG THE INSECTS[1]

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LECTURE III. PART 2. BEES SOLITARY AND SOCIAL

The Meliponinæ, or stingless bees, are a very peculiar group of nearly 250 species, all confined to warm countries. Fully four fifths of the species occur only in the American tropics and only about one fifth in the Ethiopian, Indomalayan and Australian regions. All the Old World and the majority of the Neotropical forms belong to the genus Trigona; the remainder of the American species are placed in a separate genus, Melipona. The stingless bees are much less hairy and much smaller than the bumble-bees. Some of the species of Trigona measure less than 3 mm. in length and are therefore among the smallest of bees. The colonies vary greatly in population in different species. According to H. von Ihering, those of Melipona may comprise from 500 to 4,000, those of Trigona from 300 to 80,000 individuals. The name stingless as applied to these insects is not strictly accurate, because a vestigial sting is present. It is useless for defence, however, so that many of the species are quite harmless and are called "angelitos" by the Latin-Americans. But some forms are anything but little angels. When disturbed they swarm at the intruder, bury themselves in his hair, eye-brows and beard, if he has one, and buzz about with a peculiarly annoying, twisting movement. Others prefer to fly into the eyes, ears and nostrils, others have a *penchant* for crawling over the face and hands and feeding on the perspiration, or bite unpleasantly, and a few species spread a caustic secretion over the skin. On one occasion in Guatemala large patches of epidermis were thus burned off from my face by a small swarm of *Trigona flaveola*.

There are three morphologically distinct castes. The queen differs from the worker in the smaller head, much more voluminous abdomen, more abundant pilosity, and in the form of the hind legs, the tibiæ of which are reduced in width and furnished with bristles also on their external surfaces, while the metatarsi are elongate, rounded and apically narrowed. The worker, therefore, really represents the typical female of the species morphologically, except that she is sterile, whereas the queen, except in her ovaries,

exhibits a degeneration of the typical secondary characters of her sex. There is only one mother queen in a colony, but a number of young daughter queens are tolerated. New colonies are formed by swarming, that is, by single young queens leaving the colony from time to time, accompanied by detachments of workers, to found new nests. The body of the old queen is so obese and heavy with eggs and her wings are so weak that she can not leave the nest after it is once established.

The nests of the Meliponinæ are extremely diverse in structure. They are usually in hollow tree-trunks or branches, less frequently in walls. Some of the species nest in the ground, and a few (*T. kohli, fulviventris, crassipes, etc.,*) actually build in the centers

FIG. 46
Cerumen spout, or nest entrance of a large colony of *Trigona heideri* Friese nesting in a hollow tree at Kartabo, British Guiana. About 1/3 natural size. Photograph by Mr. John Tee Van.

of termite nests. The nest is made of wax, which most of the species mix with earth, resin or other substances, so that it is chocolate brown or black and is called "cerumen." The wax is secreted only between the dorsal segments of the abdomen, and is produced by the males as well as by the workers—the one case in which a male Hymenopteran seems to perform a useful social function. The workers not only collect nectar and pollen but they seem to have a greater propensity than other social bees for gathering propolis, resins and all kinds of gums and sticky plant-exudations. And unlike other bees they are also fond of visiting offal and the feces of animals. One species is said even to eat meat (*T. argentata*, according to Ducke).

The entrance to the nest may be a simple hole, but more often it is a projecting cerumen spout or funnel, which differs considerably in different species (Fig. 46). In some East Indian Trigonas its lips are kept covered with sticky propolis to prevent the ingress of ants and other intruders (Fig. 47*AB*). In most of the South American species its orifice is guarded during the day by

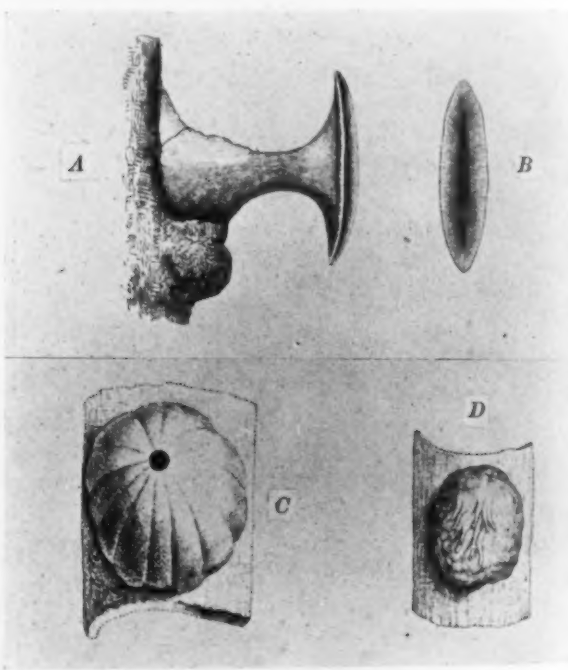

FIG. 47

Cerumen entrances to nests of Meliponine bees. *A*. Of *Trigona laeviceps* of India in profile; *B*, same seen from the front (After C. S. P. Parish); *C*, nest entrance of *Melipona quinquefasciata*; *D*, nest entrance of *Trigona limao* After F. Silvestri.

a special detachment of workers and is closed at night with a cerumen plate or screen. The interior of the nest presents a peculiar appearance. If it is in a hollow tree-trunk or branch the cavity is closed off at each end by a thick lump or plate of cerumen (the "batumen"). The nest proper (Figs. 48 and 49), constructed in the tubular space thus preempted, consists of two parts, one for the brood and one for the storage of various foods and building materials. The brood portion consists typically of a hollow spheroidal

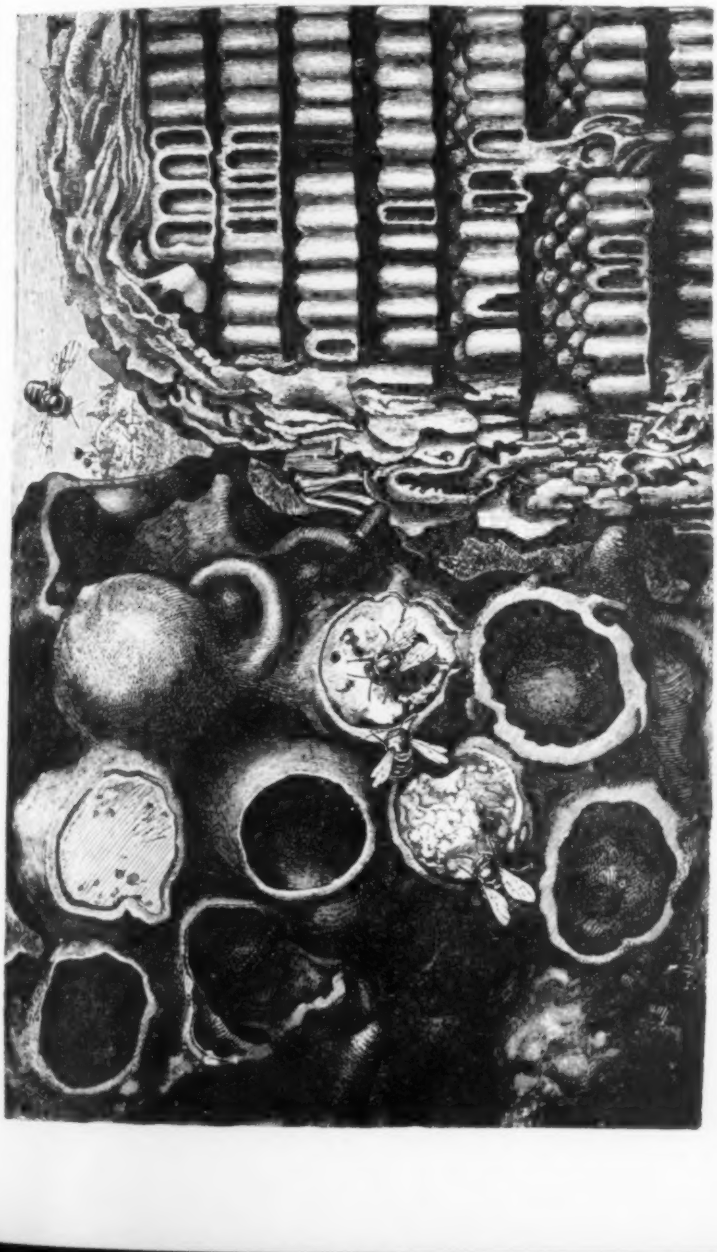

FIG. 48

Portion of nest of *Melipona scutellaris*, showing brood-comb (to the right) and the large honey pots and pollen pots (to the left). Subdiagrammatic drawing from Emile Blanchard.

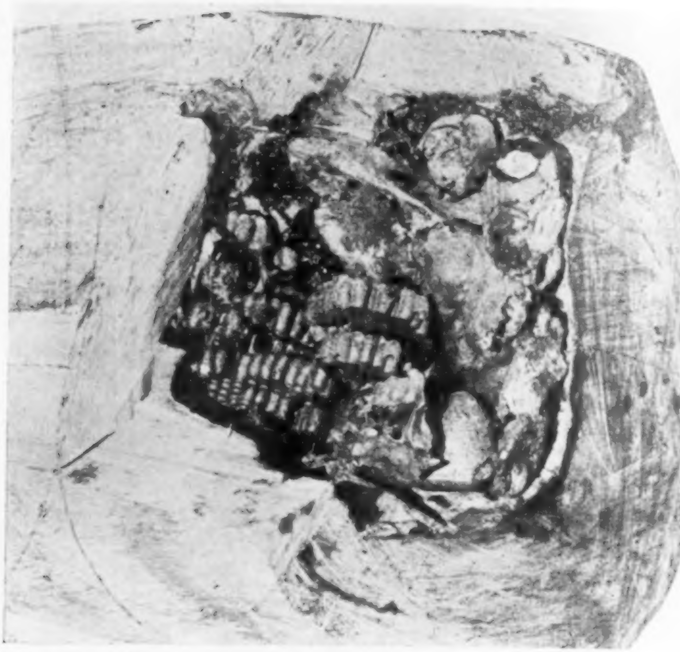

FIG. 49
Nest of Melipona sp. in hollow log, showing brood-comb (to the left), pollen pots and honey pots (to the right). Photograph by Dr. E. F. Phillips. About one half natural size.

envelope of irregular, interconnected cerumen laminæ, forming the walls of an elaborate system of anastomosing passage-ways and enclosing a large central space occupied by a series of combs of hexagonal cells. There is only one layer of cells in each comb and they all open upwards, not downwards as in the social wasps. In some species the combs are regular and disc- or ring-shaped structures, in others they are arranged in a spiral or more irregularly. Their cells are used exclusively for rearing the brood. In Melipona and some species of Trigona they are all of the same size, but in several South American species of the latter genus single larger cells are constructed, especially towards the periphery of the combs, for the rearing of queen larvæ. All this elaborate arrangement would seem to be a preparation for a very specialized system of caring for the young, but such is not the case. The workers, precisely as if they were solitary bees, put a quantity of pollen and honey into each cell, and after the queen has laid an egg in it, provide it with a waxen cover, so that the larva is reared exactly like that of a solitary bee. There is mass but not progressive provisioning and the adult bees do not come in contact with the growing larvæ. The queen-cells are treated in the same manner, the only differ-

ence being that they are provided with a greater amount of pollen and honey. Among the species whose queen cells are no larger than those in which the workers and males are reared, the queens emerge with small ovaries and develop them later, but among the species which build large cells for the queens, the latter emerge with the ovaries fully developed. These differences are of considerable interest in connection with the queen honey-bee.

Outside the cerumen involucre enclosing the brood combs the workers construct large elliptical or spherical pots, some for the storage of honey, others for pollen and in some species still others

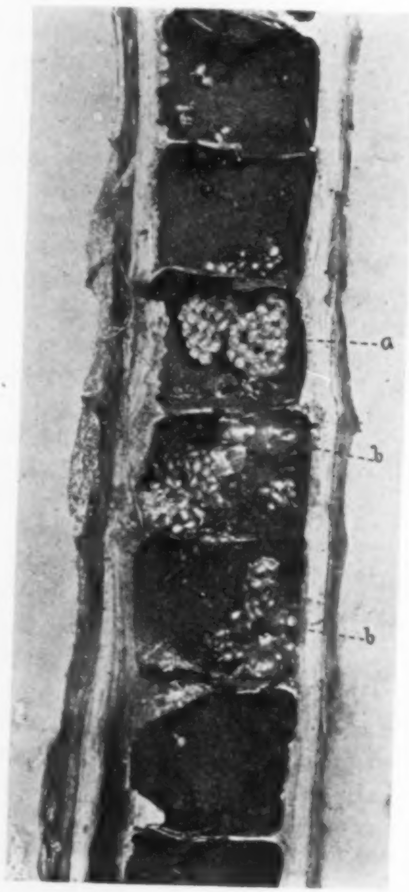

FIG. 50

Nest of a small Trigona (worker only 2.5 mm. long!) representing a new species near *T. goeldiana* Friese, in the hollow internodes of a small *Crecopia angulata* Bailey (sp. nov.) at Kartabo, British Guiana. *a*, brood-cells containing adult larvæ and pupæ; b, honey pots. Slightly enlarged. Photograph by Mr. John Tee Van.

for propolis. In one species (*T. silvestrii*) the pollen-pots are long and cylindrical while the honey-pots are small and spherical. This same arrangement is known to occur also in one of the European bumble-bees (*B. pomorum*). The Meliponinæ may also store other substances in the outer portions of their nests. In one nest of a black Trigona, which I observed at Kalacoon, in British Guiana, there were several lumps, each weighing 10 to 20 grams, of a hard substance closely resembling sealing wax in color and consistency. The species which build their nests freely on the branches of trees cover them with protective layers of cerumen arranged like those surrounding the brood combs.

The Old World Trigonas (*canifrons*, according to W. A. Schulz) and some of the South American species (*timida*, *silvestrii* and *cilipes*, according to Silvestri; *silvestrii* and *muelleri*, according to H. von Ihering; and a very small undescribed species allied to *T. goeldiana*, which I found in British Guiana, represent a more primitive stage in the construction of the nest (Fig. 50). The brood cells in these forms are elliptical and are not arranged in a comb but are isolated or loosely connected with one another by delicate waxen beams, or trabeculæ. They are therefore essentially like the cells of bumble-bees and solitary bees. It should be noted also that the Meliponinæ, like the bumble-bees, tear down their cells after they have been used and construct new ones in their places.

The rearing of the brood of all the castes in closed cells, after the manner of the solitary bees, is very significant, since it is the only case among the social Hymenoptera of a complete lack of contact between the adults and the larvæ. Even the bumble-bees open their cells from time to time and feed the older larvæ, and among the honey-bees the cells remain open throughout larval development. It is obvious that the Meliponinæ have either retained unaltered the ancient method of rearing the young in closed cells, employed by all the solitary bees, or have reverted to it after practicing a method more like that of the bumble-bees or honey-bees. As there seem to be no cogent reasons for adopting the latter alternative, I am inclined to believe that the former is the more probable and that unlike the wasps these highly social bees have never passed through a stage of actual trophallactic contact between mother and offspring. After considering the honey-bees I shall return to this question.

The Apinæ, or honey-bees, are separated by a wide gap from the Meliponinæ and Bombinæ and their origin is still wrapped in obscurity. Certain species, referred by their authors to the genus Apis, are recorded from the European Miocene (*A. adamitica*), Baltic Amber and Upper Oligocene (*A. meliponoides* and *hen-*

shawi). The genus as it exists to-day comprises only four species: *dorsata*, *florea*, *indica* and *mellifica*, the common honey-bee of our apiaries. *A. indica* and *mellifica* are so very similar in structure and habits and hybridize so readily that both Friese and von Buttel-Reepen have regarded the former as a mere race, or subspecies of the latter. Von Buttel-Reepen, however, has recently raised *indica* to specific rank on what seem to me to be rather dubious grounds. Inasmuch as *dorsata*, *florea* and *indica* are confined to the Indomalayan region, it has been usually assumed that *mellifica*, though now cosmopolitan, is also of South Asiatic origin. But von Buttel-Reepen believes that it had its origin in Germany and bases his opinion on the existence of the above-mentioned fossils in Germany and on the fact that the true *mellifica* did not exist in India till it was introduced by Europeans. The bee originally kept in that country by the natives was *indica*. The eminent melittologist's view is so startling that one is tempted to suppose that he, like some other German investigators, is the victim of a desire to make his fatherland the source of all good things. The following considerations seem to me to leave little ground for his opinion: First, if *mellifica* was not originally present in India it is probably because *indica* happens to be the South Asiatic race of the species. Second, the type of *mellifica*, that is, the form to which Linnaeus first gave the name, is, of course, the dark German, or northern race, and it is natural to regard the many local races and varieties in other parts of Europe, in Africa and Asia as mere modifications of the German type. But such a procedure is unwarranted in phylogeny, since the selection of the German race as the specific type was a mere taxonomic accident. Had a Hindoo entomologist preceded Linnaeus, *indica* would be the type of the species, and the Hindoo, aware of the existence of two other species of Apis in his and neighboring countries and nowhere else, would properly regard the genus as of South Asiatic origin and the species *indica* as having spread to Europe and Africa and as having produced among others a dark Germanic race. Third, it is by no means certain that the fossil forms, which have been described from imperfect specimens, really belong to Apis or that they are in the direct line of descent to that genus. And even if we admit this to be the case, it does not follow that they must have originated in Germany. Fourth, granting that a race of *mellifica* existed in that country during the Miocene, it must either have become extinct during the Ice Age or have been driven into Southern Europe. That this identical race and not a new one arising from southern forms later returned to Germany is a pure supposition. Fifth, the tropical origin of the honey-bee is indicated by its in-

ability to form new colonies except by swarming, precisely like the tropical Meliponinæ and Vespidæ. And while it is true that the climate of Central Europe during the Oligocene and Miocene was tropical or subtropical, the existence at the present time of at least three distinct species of Apis in the Indomalayan region and nowhere else makes it seem much more probable that the ancestors of *mellifica* emigrated from Asia into Europe than in the reverse direction, especially as Southern Asia is a well-known center from which many other animals have been distributed. The spread of the honey-bee throughout the world is evidently due to its extraordinary adaptability to the most diverse flowers and to a great range of temperature, to its habit of storing large quantities of honey and its ability to maintain a rather high temperature in the hive during periods of cold weather. This unusual plasticity is peculiar to the species and is not the result of domestication. The insect, in fact, has never been domesticated.

FIG. 51

Honey-bee (*Apis-mellifica*), *a*, worker; *b*, queen; *c*, male (drone). Twice natural size. After E. F. Phillips.

Like the Meliponinæ the species of Apis have three well-developed castes (Fig. 51). Normally there is only a single queen in the colony and she will not tolerate the presence even of another young queen. Swarming takes place by the old queen leaving the colony accompanied by a large detachment of workers when a young queen is about to emerge from her cell, and if several young queens are to emerge in succession, the older leaves before the next appears. It will be noticed that this is different from the swarming of the Meliponinæ, since in these bees the old queen remains in the nest and the young queens accompany the swarms of workers. When the queen's eggs are fertilized they develop into workers or queens according to the way the larvæ are fed, but when unfertilized into males or drones, as is also the case with the eggs that

are sometimes laid by workers. All the species of Apis make pendent combs of pure wax, which is secreted only by the workers and only between the ventral segments of the abdomen. The combs differ from those of the Meliponinæ and wasps in consisting of two layers of hexagonal cells, and the brood cells remain open throughout larval development, the young being fed progressively. The three species of Apis represent as many different phylogenetic stages, which may be briefly described.

A. dorsata is the largest and most primitive form (worker 16-18 mm.; queen 23 mm.; drone 15-16 mm.). It builds from the lower surface of a branch a single large semicircular comb, sometimes with a superficial area of a square meter. Its cells are regularly hexagonal and all alike. Part of them are used for storing honey, the remainder for the brood. In this species, therefore, the workers, queens and drones are all reared in cells of the same size and shape, like the species of Melipona and many Trigonas. *A. dorsata* is a nomadic bee, which builds its comb where flowers are abundant and after they have ceased to bloom deserts the structure and builds a new one in fresh pastures. Owing to this habit, all the attempts that have been made both in Europe and the United States to establish this bee in apiaries have failed.

A. florea is the smallest species in the genus (worker 7-8 mm.; queen 13-14 mm.; drone 12 mm.) and in certain respects represents an interesting transition between *dorsata* and *mellifica*. The drone is peculiar in having a finger-shaped process on the inner border of the hind metatarsus. Like *dorsata*, *florea* makes a single pendent comb, but it is much smaller and narrower and consists of four different kinds of cells. At the base where the comb surrounds the supporting branch the cells are hexagonal, large and deep and are used for storing honey. Below these there is a broad zone of small hexagonal cells for the worker brood and at the apical fourth still larger hexagonal cells for the drone brood. Finally, attached to the free border and depending like stalagtites there are several long conical cells for the queen larvæ.

A. mellifica and its subspecies *indica*, etc., differ from *dorsata* and *florea* in nesting in hollow cavities (tree-trunks, caverns, hives) and in constructing several pendent combs side by side, each presenting the types of cells seen in *florea*, except that there is no special type for storage, the honey being kept in cells like those used for rearing the worker brood. Moreover, the queen cells are never built on drone but only on worker comb. The singular shape of the queen cells (Fig. 52), so very different from the hexagonal cells, and the fact that they are the only cells torn down by the workers after being used, indicate that they are archaic

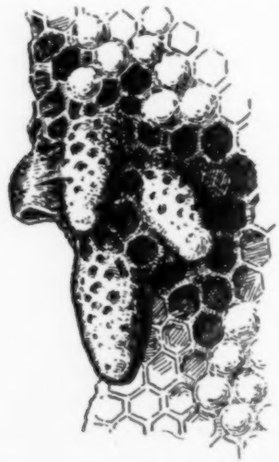

FIG. 52
Queen-cells of the honey-bee. Natural size. After E. F. Phillips.

structures of considerable phylogenetic significance. They are, indeed, reminiscent of the only type of cell constructed by the bumble-bees. But owing to the fact that conical queen cells occur only in *A. florea* and *mellifica* and are the same in both species we are unable to advance any reasons for their retention among cells of the highly specialized hexagonal type. On rare occasions

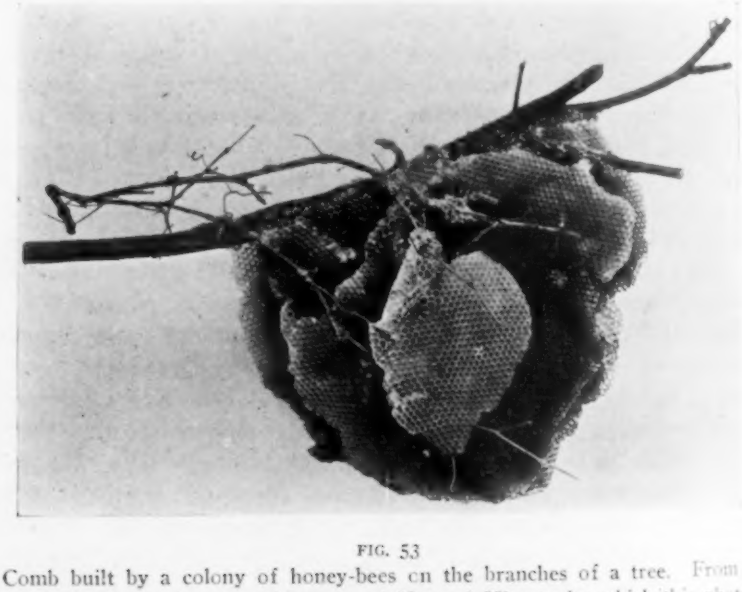

FIG. 53
Comb built by a colony of honey-bees on the branches of a tree. From a specimen in the American Museum of Natural History by which this photograph and Fig. 54 were contributed.

a swarm of honey-bees, failing to find a hive or hollow tree-trunk, will construct its comb among the branches of trees or bushes. Such exposed nests have been described by Bouvier, and there is an unusually fine example in the American Museum of Natural History (Figs. 53 and 54). It will be noticed that in form each comb resembles the single comb of *A. dorsata* or *florea*.

Except in the development of her ovaries, the queen honey-bee is a degenerate female, a mere egg-laying machine, entirely dependent on her worker progeny. The pollen-collecting apparatus of the hind legs, so well developed in the worker and so charac-

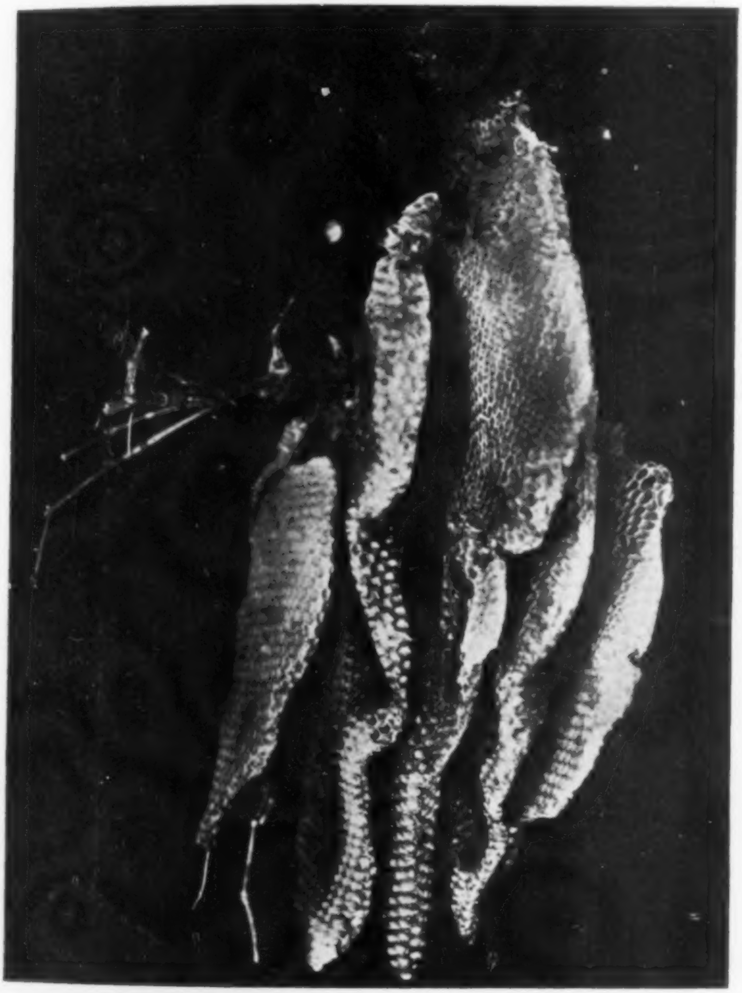

FIG. 54
Same comb as shown in Fig. 53, seen from the end.

teristic of the females of all non-parasitic, podilegous bees and of the queens of the bumble-bees, is undeveloped, her tongue and sting are shortened, her brain is smaller and she lacks the pharyngeal salivary glands of the worker. That these differences are due to larval feeding is proved by the experiment of transferring eggs and very young larvæ from worker to queen cells and *vice versa*. Transferring eggs from drone to worker or queen cells does not, however, alter the sex of the insect reared, since it develops from an unfertilized egg. Under normal conditions the time required for the development and the chemical composition of the food administered to the larvæ differ for the three castes. The difference in the rate of development is shown in the following table from von Buttel-Reepen:

DURATION OF DEVELOPMENT IN THE HONEY-BEE
(After von Buttel-Reepen)

DEVELOPMENT OF THE BROOD	QUEEN (DAYS)	WORKER (DAYS)	DRONE (DAYS)
Duration of egg (embryonic) development	3	3	3
Duration of larval development	6	6	6
Duration of spinning and resting period	2	4	7
Change of pupa to imago	5	8	8
Total	16	21	24

The composition of the food, which, for the queens and the earliest stages of the workers and drones, is a secretion ("royal jelly") of the pharyngeal glands of the worker nurses, is shown in von Planta's table taken from the same author:

COMPOSITION OF LARVAL FOODS OF THE HONEY-BEE
(After von Planta)

PERCENTAGES OF DRIED SUBSTANCE	QUEEN LARVÆ (AVERAGE)	DRONE LARVÆ UNDER 4 DAYS	DRONE LARVÆ OVER 4 DAYS	DRONE LARVÆ AVERAGE	WORKER LARVÆ UNDER 4 DAYS	WORKER LARVÆ OVER 4 DAYS	WORKER LARVÆ AVERAGE
Proteid	43.14	55.91	31.67	43.79	53.38	27.87	40.62
Fat	13.55	11.90	4.74	8.32	8.38	3.69	6.03
Sugar	20.39	9.57	38.49	24.03	18.09	44.93	31.51

We see from these tables that the queen, although the largest of the three castes, reaches maturity in about 16 days. She is fed only on "royal jelly," without admixture of honey or pollen. These highly nutritious rations (43.14 per cent. proteid) are undoubtedly responsible for her very rapid growth. The worker is given pollen and honey after the fourth day and requires 21 days to complete her development. The feeding of the drone is similar, but he receives less sugar and more fat and his development is protracted to 24 days.

The foregoing considerations suffice to show the complexity of the whole matter of sex-determination and caste-differentiation in

the honey-bee. There are libraries of contentious discussion of these subjects, which can not, of course, be adequately treated in a general lecture. Although all competent authorities agree that the drones arise from parthenogenetic or unfertilized eggs and the queens and workers from fertilized eggs, it is impossible, in the present state of our knowledge, to decide between two different theoretical interpretations of the facts. According to one, first stated by Dzierzon and more recently maintained by Weismann and his pupils and especially by von Buttel-Reepen, the queen lays only one kind of egg, which is potentially indifferent but has its sex determined at the moment of fertilization; according to the other, advocated by Beard, von Lenhossek and Oscar Schulze, there are really two different kinds of eggs, one of which does not need to be fertilized and develops into the drone, whereas the other requires fertilization to be viable and develops into a queen or a worker. Normally the queen lays unfertilized eggs only in the large drone cells and fertilized eggs only in the small worker cells and the peculiar conical queen cells. The hypothesis that the difference in the width of the cells is the stimulus which causes the queen to close or open the duct of her spermatheca and thus prevent or permit the exit of sperm while the egg is passing from the ovaries on its way to being laid, can not be accepted, because the queen often oviposits in cells which have had only their basal portion completed. Moreover, this hypothesis will not apply to the Meliponinæ, which rear males and workers in closed cells of the same size or to cases like those of the solitary wasps described in the preceding lecture and many solitary bees which regulate the size of the cell and the amount of provisions according to the sex of the offspring. These peculiar phenomena, first observed by Fabre in Osmia, Halictus and Chalicodoma, have been recently confirmed by Verhöff, Höppner and Armbruster. The observations show that the female bee must be aware of differences between her eggs sometime before she begins to lay them and certainly before there are any such stimuli as contact of her abdomen with the walls of the cell.

Referring to the Dzierzon theory, Phillips says: "The facts observed in the apiary on which this belief is based are as follows: (1) If a queen is unable to fly out to mate or is prevented from mating in some way she usually dies but if she does lay eggs, as she may, after three or four weeks, the eggs which develop are all males; (2) if when a queen becomes old her supply of spermatozoa is exhausted, her offspring are all males; (3) if a colony becomes queenless and remains so for a time, some of the workers may begin egg-laying and in this case too only males develop. The

author has found that many eggs laid by drone-laying queens fail to hatch and, in fact, are often removed in a short time by the workers. This makes it impossible for us to accept Dzierzon's statement that all eggs laid by such a queen become males and the statement must be modified as follows: all of those eggs laid by a drone-laying queen which develop become males. The potentialities of the eggs which never hatch are not known. In addition to the facts here stated, the theory of the parthenogenetic development of the drone is supported by investigation of the phenomena of development in the egg." He becomes more explicit in the following passage: "If we take into consideration the important fact that not all eggs of an unfertilized (drone-laying) queen hatch, then the bee does not appear as an exception in nature. It seems clear, however, that the statement of Dzierzon that all the eggs in the ovary are male eggs can not be accepted and it is, in fact, not improbable that the eggs destined to be females die for want of fertilization, while the eggs destined to be males, not requiring fertilization, are capable of development. It should be understood that the casting of doubt on Dzierzon's theory of sex determination does not invalidate his theory in so far as it pertains to the development of males from unfertilized eggs."

There are also several cases of hybridization that seem to indicate that Dzierzon's theory is only a partial or approximate interpretation. When a yellow Italian queen bee mates with a black German drone, the drone offspring, being fatherless, should of course be yellow like the mother, whereas the workers should combine the characters of both their parents. This is often the case, but although von Buttel-Reepen is a staunch supporter of Weismann and adheres rigidly to the Dzierzon theory, he is compelled to admit that occasionally "when an Italian queen is fecundated by a German drone, numerous blended hybrids ("Mischlinge") appear during the first year, but during the second year almost exclusively Italian, and in the third year exclusively Italian workers are produced, so that the population must be regarded as purely Italian." He has himself witnessed this phenomenon and states that it has also been observed by Dönhoff, Dzierzon and Cori. The only explanation von Buttel-Reepen has to offer is that the sperm, stored in the spermatheca of the queen, may in the course of time be increasingly affected by the secretions of her spermophilous glands, which keep the paternal elements alive during the three to five years of her life. The facts can hardly be explained on Mendelian principles even if we make all due allowance for the impurity of the German and Italian strains that produced the hybrids. It looks as if, at least under certain conditions, workers

might develop from unfertilized eggs. According to Onions, the workers of a South African race of honey-bees are able to produce workers parthenogenetically, and Reichenbach, Mrs. A. B. Comstock and Crawley find the same to be true of worker ants of the genus Lasius.

I believe that Phillips, in the remarks above quoted, suggests an important fact which has been too little noticed and may account for much misunderstanding in regard to sex determination in the honey-bee. Accurate knowledge of the life-history of a particular individual in a colony of social insects is almost or quite unattainable, for two reasons: first, the egg can not be isolated and the larva brought up by hand, like a young chick, because it requires the presence of nurses of its own species and they will not rear it under abnormal conditions; and second, the workers of many social insects are very fond of eating the eggs and young larvæ and these same workers or the queen not infrequently at once lay eggs in the place of those devoured. This behavior is especially common and disconcerting among the ants. Now a rigid control would require not only that the mother insect should be observed during the very act of oviposition but that the egg and resulting larva should be kept under constant observation day and night till the completion of development. A relay of observers, changing every few hours for two or three weeks, would therefore be needed in order to make sure that a particular adult had developed from a particular egg, and it would be necessary to observe many individuals in such a manner before we should have the data for accurate conclusions. In fact, we shall need all the resources of a specially equipped laboratory, with a specially trained staff, for any final solution of many of the peculiar developmental problems suggested by the honey-bee and other social insects.

Among these problems we should also have to include that of the differentiation of the two female castes, that is, the problem as to whether the worker and queen arise from one kind or from two different kinds of eggs. The experiments of transferring larvæ of different ages from worker to queen cells, as previously stated, and the existence of series of transitional forms between the worker and the queen, naturally lead to the view that there is only one kind of female egg and that the character of the larval food after the fourth day determines whether the adult is to be a worker or a queen. This may be true of the honey-bee, but, as we shall see, observations on certain ants and termites indicate that there may be more than one kind of female egg.

The main object of the rich and abundant food administered to the larva of the queen honey-bee is evidently the rapid develop-

ment of her ovaries, so that she may begin to lay eggs very soon after emergence. This is also indicated by the conditions in the Meliponinæ. The Melipona queen, which is reared in a closed cell of the same size as that of the workers and on the same amount of food, emerges with rudimentary ovaries and has to develop them by subsequent feeding during her adult instar, whereas the Trigona queen, which is reared in a large cell with more food than is given to the worker larvæ, emerges with mature or nearly mature eggs in her ovaries. All these queens, however, are distinguished from the cospecific workers by certain degenerate or primitive characters, which, it would seem, must owe their peculiarities either to the indirect, inhibiting or modifying action of chemical substances (enzymes) in their food or to the more direct action of hormones, or internal secretions produced by the developing ovaries. The great size of the ovaries in the queens of all these social bees accounts, of course, for their extraordinary fecundity and the size of their colonies. Cheshire computed the number of eggs which may be laid during her lifetime by a vigorous, fecundated honey-bee queen as about 1,500,000, and, according to von Buttel-Reepen, we should find in her spermatheca no less than 200,000,000 spermatozoa. It is not surprisisng, therefore, that a hive, at the time of its climax development during the early summer, may contain 50,000 to 60,000 or even 70,000 to 80,000 bees.

In conclusion I may refer to one of the negative peculiarities of social bees—the absence of that peculiar interchange of nutriment between the adult and larva, or trophalaxis, which seems to be a powerful factor in integrating and maintaining the colonies of the social wasps. Among the Meliponinæ the food and egg are simply sealed up in the cell, so that there can be no contact between adults and larva, and even the honey-bee worker does not place the food on the mouth of the larva but pours it on the bottom of the cell where it can be imbibed when needed. So far as known, the bee larva, unlike the wasp larva, produces no salivary secretion to attract its nurses, though it might be going too far at the present time to say that this is certainly not the case. It is quite probable, nevertheless, that the sources of the development and perpetuation of adult and larval contact, so essential to the maintenance of social life among the Bombinæ, Meliponinæ and Apinæ, are to be looked for in other directions. Hermann Müller long ago pointed out, as I stated in the preceding lecture, that the transition of the adult wasp from an insect to a nectar and pollen diet was due to economy of food. These latter substances represent a very concentrated and energizing food supply and one that can be

more readily obtained in great abundance than insect food. Hence it is not surprising that a large group of insects like the bees has become so exquisitely anthophilous, and that the exploiting of larval secretions is unnecessary. It will be noticed that all three subfamilies of social bees store quantities of pollen and honey in open cells and such easily accessible stores of liquid and very finely divided food make even the reciprocal feeding of the adult workers in bee colonies superfluous. This storage of food may be at least one of the reasons why such exchanges of nutriment as we observed among the social wasps and shall see again in a more exaggerated form among the ants and termites were either never developed or were long ago discontinued by the social bees.

THE PATH AS A FACTOR IN HUMAN EVOLUTION

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THE path and the wilderness, formerly in harmony, are now at odds. Certain elements of the wilderness are essential to the best evolution of man. The path is also essential; therefore a reasonable measure of harmony between it and the wilderness should be restored and retained. This restoration and retention might be included in our broad term conservation.

Millions of years before man became human some of the primitive worms and insects made paths; some of the lower vertebrates did likewise, and many of the earliest mammals of remote Triassic times doubtless made paths and runways of many sorts. The Triassic, Jurassic and Cretaceous together constitute the Mesozoic, or age of reptiles, which according to some geologists lasted nine million years; and throughout this long time our earliest mammalian ancestors were small creatures, the largest not exceeding a rat or rabbit in size, hiding for their lives from many a reptilian foe, both large and small.

With the close of the age of reptiles and dawn of the age of mammals, which some estimate to have been three million years ago, mammalian species evolved with great rapidity and in many directions. Mammals small, medium and large, and of wonderful diversity were produced. Of these some still made paths of one sort or another, and many of their constantly evolving offspring continued to do likewise.

Among our modern mammals we now find many famous pathmakers. When man's more recent ancestors departed from arboreal life and remained more upon the ground again, like their remoter pre-arboreal ancestors, they must have made frequent use of the ready-made paths of their contemporaries, some of which fell victims to early man, while others at times made of him a victim. From that time, throughout the many thousands of years of savagery man made an increasing use of paths, himself becoming an important pathmaker where he walked from place to place repeatedly, yet often departing from his paths to search the all-surrounding wilderness.

Some of the ablest students of human evolution to-day assert that earliest man lived in a part of Asia where the physiography and climate were changing so that the abundant rain-forests were gradually forced to give place to a dryer and more open park-like country; changes which obliged the arboreal inhabitants either to migrate or to perish or to modify their mode of life. Potent as such environmental changes may have been as aids to man's transformation from an arboreal creature to a terrestrial man, there were doubtless other deeper-seated factors contributing to the same end. This change from an arboreal to a terrestrial life has been a fruitful field for thought research and discussion among men of science, and it is likely that more thoroughgoing investigation may throw more light upon it. But this is a digression from my theme. Whatever the causes, the fact of the change is plain, and not doubted by any biologist.

Throughout the long, ensuing age of human savagery man had his paths, yet breathed the same pure, dust-free air to which the lungs of his mammalian relatives and ancestors had been accustomed. The lungs of his reptilian and amphibian relatives and ancestors breathed air equally pure.

The age of savagery gave place to the age of barbarism. Some of man's paths became crude streets and highways. Domestic animals, small or large, strayed or were driven along the ways. The wilderness became more netted with paths, and portions of it here and there gave place to crude agriculture. But it still was essentially the same wild, beautiful, fascinating thing. Wonder and mystery, game, adventure, peril, excitement and peace were found in the wilderness. The forests and the mountains, the lakes, valleys and streams ever lured the early children of men to wander into the wilderness, seek out its treasures, and learn its secrets by a life of daily familiarity. Some, less bold, dreaded the wilderness. Some, precocious in urbane awakenings, kept to the beaten paths. Some, indolent or effeminate, stayed to be pampered or scolded by the women. None of them remained within cave or within hut very long, for daylight was preferable to darkness or flickering firelight when storm or sleep did not drive them in. Window glass was not to come until long after civilization had replaced barbarism. Any opening in a dwelling admitted not only light, but volumes of outdoor air. Woman's work must be done out in front of the primitive dwelling place for light. The indoor life could not be lived by any one. Such were our forerunners for countless generations. Our artificialities of the present day are of mushroom growth, having sprung up, as it were, in a moment in contrast to the long ages we have been living the more natural, outdoor life. Our muscles were built for daily exertion, prolonged and varied,

not for the rocking chair, office chair and automobile. Long hunts over the mountains, long toil in the fields or at domestic tasks, these were what trained our muscles, developed our frames, and made our forebears the sturdy, worthy stock from which our virile race has sprung. To-day are any of us wasting, through disuse, our inheritance of strength? Are any developing one-sidedly a well-rounded nature? Do any miss the free, large, open spaces, the virgin forest, the untrammeled wilderness? Do any long to step forth in the morning into a world of natural beauty, reaching out in boundless prodigality as far as the eye can see? Do any feel a sense of loss, as though something great had gone, not easily to be restored? It would not be strange if many felt such secret stirrings, after so long an inheritance in the wilderness and so short an adaptation to our present conditions. The wonder is that so many should have lost, in a few paltry centuries, or even in a few actual years, the inheritance and the instincts of the ages. Man's marvelous plasticity has made possible to-day's civilization. The human species has shown great adaptability and variability, a distinction which is shared by many other species, notably the internal parasites, which have made such peculiar changes of habit and habitat in adapting themselves from a free outer life to a life of confinement and parasitism within some organ of its host. Many and curious are the changes of life habit which these species have undergone; and not only have their habits changed, but their external and internal structures have been modified, in some cases involving the loss of most of the nervous system and all of the digestive system. There has not yet been time for man to undergo any physical changes so far-reaching and so permanent as these, but in the little time in which our European ancestors have crowded their paths and their dwellings together into what we call cities, with their smoke and dust and artificial floor and scenery, our life has changed to such an extent that our bodies are changing in response so quickly as to alarm the trained physical examiner.

Life in factory and office and store and home is as different from the life our ancestors led through the ages as can well be imagined, more different even, in its essential features, than our terrestrial wilderness life was from the preceding arboreal life. The effects on both mind and body are equally radical. The ever plastic human being responds to these inner and outer changes with a speed which, compared with the geological ages of past evolution, bids fair to produce a radically different creature from that which we have known as our human selves in the past.

Three courses are open to us, and a fourth might be conceiv-

able, but this fourth—a complete break with "modern civilization"—does not seem at all probable. These three courses are: (1) that the whole human race be involved in the rapidly growing whirlwind which in its present stage of development we call, rather proudly "our civilization" as though we had deliberately planned it as a complete entity, when no one ever conceived of such a thing, and no one even to-day has the ability properly to evaluate the civilization now in existence; (2) that a part of the human species, reluctant to mutate or evolve into the strange new species which the onward sweep of "civilization" is producing, deliberately keep themselves apart in the yet remaining open places, guarding these zealously as the domain of the creature known to-day by scientists as *Homo sapiens,* the remainder of the race evolving rapidly into some other kind of *Homo,* or even into a different *genus* in time; (3) that the entire race of *Homo,* not wishing to become anything other than *sapiens,* but rather more so, and making use of all his splendid new means of intercommunication the world around, construct an intelligent plan to conserve all the best that the wilderness contained and preserve these perpetually in close conjunction with the best, and only the best, which innovations have to offer.

The wilderness and the path, so easily at odds to-day, must be restored to harmony, a harmony built upon a foundation which cannot again be shaken. The best of all that earth and heaven can yield is none too good for lordly man as he aspires to a better, greater man in future.

Many questions will arise in evaluating the permanent worth of the host of innovations daily pressing their almost irresistible claims upon us. But we will not willingly let the spirit of the machine grind us in its cogs until we are ourselves converted into mere machines of clay, reflecting the nature of the machine—civilization—which ground us.

The great machine civilization, embracing all its component machines and inventions and discoveries and methods of life, would then need to be kept thoroughly human, humanized by all the best that is in the human heart, with all the love of the beautiful, with all the esthetic joy in wild and lovely scenery, with all the satisfying health from breathing air of wilderness purity, with all the thrill of action when the muscles and sinews of the man propel him exultantly through the forest, over the mountains and through the waters. No mere combination of automobile and cloud of dust and office chair can truly satisfy the *Homo sapiens* of the ages. The path must lead quickly to the wilderness. The wilderness must even pervade and beautify the aggregations of our paths. The bare, artificial ugliness of the modern city must be stripped

from it and in various ways replaced by natural beauty. The dust nuisance must be completely removed from all roads and paths, which should be clean and sweet as the woodland lane, and these roads should be so wisely and artistically planned that as few as possible may suffice. The wilderness should everywhere be encouraged and perfected and utilized to the full.

The wilderness is fully able to supply to the maker of paths much which will administer not only to his esthetic joys, but also to his highest and most lasting economic good. The ideal world, in the future, will perfectly harmonize and blend the wilderness and the path.

The function of the path as a factor in human evolution has been apparent throughout the preceding lines. Upon the number, arrangement and nature of these paths, roads and streets depends the nature of our civilization and the nature of the life we lead, and this in turn reacts constantly upon ourselves, "body, mind and estate." By our evolution we mean all those changes which take place in our habits of life and thought, as well as the physical changes constantly taking place in all living beings. Man is one of the most plastic and changeable of beings, quickly responding to factors of every sort.

Man can not, even if he should wish to, remain the same from one century to another. Recent centuries have marked, perhaps, the greatest changes in the given time, for the greater changes in our past were the product of uncounted ages. The path will always be an important factor in our progressive evolution by reason of the profound, or better, the fundamental bearing it has upon the kind of life we lead and the kind of being we are or are to become.

Where the path leads man will follow. To the kind of path man's foot conforms itself, and his lungs and his mind and his muscles and his stomach and his spirt are all affected directly or indirectly by the nature of the path and where it leads. Man may to a great extent be the creator of the world he lives in; he will always be its mirror.

Useable as far after math: There are no theories here.

WHY DO WE LAUGH?

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ONLY those who have taken the world seriously can see the humor of it, and only those who have a keen sense of humor can afford to take it seriously. The funny grows out of the serious as much as it grows out of the humorous. It is only in so far as the ancients took themselves and their dogmas seriously that we can laugh at them; when we find them laughing at themselves we have hit upon something worthy of our serious consideration, for their laughter is the gauge of their seriousness.

It is the serious which unwittingly reveals the shallows, as it is the comic which often plumbs the serious to its depths. It is only because the child takes his pretensions seriously that we find them funny; his merriment is not itself funny, though it may sympathetically arouse us to share his laughter. In the latter case, however, we laugh with rather than at him. Oliver Wendell Holmes has said that we start by laughing with a man at his jokes, but in course of time come to laugh at him. This happens only when he attaches too much importance to his jokes.

As laughter is one way of appraising the serious, so the comic must be taken seriously if it is to be rated at its true value. No one understands a joke by laughing at it; he laughs at it because he understands it. He must moreover, understand it in a flash, not by a gradually dawning comprehension. To arouse laughter, his appreciation of the "point" of the joke must be almost instantaneous, however long he may be in preparing for that appreciation. He must have a direct and clear intuition of the situation, rather than a dim consciousness of it. He must see it in its fullness rather than in its parts.

Laughter is essentially a social phenomenon, almost as much so as is language itself, the two being very similar in origin as in function. "Laugh and the world laughs with you" may be true when there is a world society; at present, "Laugh and your social group laughs with you" would come nearer the truth. Or let us put it differently and say that when you laugh and how you laugh depends upon how and when your group laughs, much as your sentiments and language are determined by the sentiments and

language of the group. As people mumble to themselves, so they may chuckle to themselves; yet laughter is no occupation of a Robinson Crusoe, but the pursuit of a man whose life is spent amid that of his fellows. Laughter, moreover, serves a useful purpose in group life, especially on the lower levels where solidarity and uniformity are necessary in the competition with surrounding groups. It implies a common standard and is an efficient instrument in holding the group to that standard—a much more efficient instrument than scolding. A man who cannot laugh is no social being and is scarcely human. We find no human societies in which laughter does not figure as part of the social life, as, in fact, a part of the group language. If scorn is the lash, laughter is the jolly policeman who keeps the social traffic going after the approved manner, whose power inheres not in itself, but lies in the tribal standard which it bodies forth. Ethnologists have not found a group of human beings who are devoid of laughter of this sort. A few examples of the expression and repression of laughter in primitive society will make clear its social utility.

In their perverted pedagogy, the Australians teach the youths what to do by showing them the things they should not do. As part of the ordeal of training through which the young men pass when being initiated into the tribal life, the old men perform ridiculous pranks which the youth must watch, always restraining the laughter which they tend to give way to at sight of these exhibitions. A large part of these initiation ceremonies is designed to give the young men a respect for their elders, this being one way of inculcating such respect. Laughter at a person is, in a sense, an assertion of superiority to him, and the youths may not risibly make such assertion. The performance would be ridiculous if done by any other than the aged. Performance by the aged takes it out of the realm of the laughable, for the elders set the standards for the group. An aged Fijian told Erskine that he was going out to bury himself because he could not stand the jeers and laughter of the ladies of the tribe, and said some caustic things about the callousness of a European who did not care whether he was laughed at or not. An Eskimo has little of the sensitiveness which we associate with the intimacies of domestic life, but he cannot stand the derision and laughter of a rival. He will sometimes break over the tribal rules and kill the man who laughs at him. He laughs best who laughs last—that is his argument, and it is a convincing last word in the dispute. The tribesmen in the plains area of North America are among the most tireless and daring warriors in all primitive society, yet they can not stand the laughter, directed against them, of their fellow-men. Laughter is one

of the principal means of holding in line the members of the various warlike organizations which flourish in these tribes. A man of one of these societies who resents the abduction of his wife by a fellow-member, this being no violation of the rules of his order, is laughed at by the other members of the organization until his resentment passes.

Let these examples suffice. They show that laughter is a means of expressing and maintaining the group standard. It reminds people of their place in the social group and is an efficient, if gentle, reminder that they had better keep where they belong. It is an expression of the proprieties of the occasion to which the individual must attend.

When a person laughs at himself, he is, in the main, assuming the group standard, applying to himself the standards which the group applies to him. He assumes in his own person the duties of policing his conduct.

Little wonder, then, that the group should regard with serious concern the individual who is lacking in the faculty of laughter. He is largely on a par with the man who can not render military service to the group, who can not serve his fellows in the very important enterprise of bringing into effective use that group standard which makes for unity, though for unity at the price of uniformity. He may be amenable to group standards, but he is useless in the important task of holding others to that standard.

Laughter, it follows, is individually as well as socially self-preservative. The laughter of the virtuous man is not that of the vicious, for the virtuous and the vicious belong to different groups and are maintaining different standards. There is no equality in which there is no equality of laughter, no democracy in which there is no democracy of laughter, no shifting of standards unless there is a shifting in the things which elicit laughter.

There are, of course, marked intellectual elements in laughter. The individual may laugh at the group and at their laughter. Whether he does so depends upon his appreciation of group standards and upon his acceptance of them. His laughter at them expresses this assumed superiority over them.

Perhaps the most frequent intellectual element in the situations which elicit laughter is recognition of the unusual or of the unexpected. This frequently harks back to appreciation of departure from, or unexpected conformity with, group standards. We suddenly perceive the situation as in keeping with, or as out of keeping with, the social program, as a neat way of humiliating the haughty, subduing the insubordinate, or thwarting an unexpected departure from social routine. The intellectual element is largely social.

A like-minded social reference tints the psychological elements accompanying laughter. The experience is usually pleasurable, though this is conditioned by the extent to which our laughter is taken up by others who are present, that is, by the extent to which it is appreciated by the group. To laugh when no one laughs with you may be painful.

Laughter is not always elicited by the pleasurable, nor is it always the expression of pleasure. It may be a means of expressing displeasure at personal pretensions. We may laugh in spite of ourselves, though to the spite of another, and to our shame and remorse, ashamed and sorry even while we laugh. These uncontrollable outbursts show the extent to which we are held in the grip of the group standard, and the extent to which we enjoy our assumed superiority.

This sense of elation upon the part of the laugher is almost always present. It is not the mechanism of the man who stumbles or fumbles which arouses our laughter, as Bergson would have us believe; it is rather our elation at our own superiority. If we know that we must immediately pass through a similar test and will do no better than did he, his action is to us not nearly so funny as it would otherwise be. We laugh at the sprightly middle-aged man whose sight and agility should have saved him from the banana peel; but we pity rather than laugh at the aged cripple who had not these aids of discrimination and ready reflexes. Yet the latter action is much more mechanical than the former. It is true we recognize our superiority to the latter, but we do not recognize it in any sense of elation, for we have not placed ourselves on the same plane for comparison. With the middle-aged man who is like unto us it is different: he indiscreetly does what our discretion would not permit us to do. The behavior of the feeble-minded elicits no laughter from those who have a lively sense of what feeble-mindedness means; but these same actions may elicit laughter from those who do not know that the performer is feeble-minded, or for whom this information conveys no real knowledge of his condition. We laugh, in fact, not so much at the act as at the person performing the act. This is as true of the situation on the stage as of those in daily life, when alone as when in a group. Pascal asked: Why do we laugh at a fool, but do not laugh at the cripple? and answered: The one is crippled in mind, but does not know it; the other is crippled in body, but knows it. But, as was mentioned, if he is a congenital mental cripple, we do not laugh at him; it is only because he ought to know better that we laugh at him, never because he can not know better.

Now laughter, like any other social tendency, easily overflows

the channels of its social usefulness and may become a social calamity rather than a social blessing. We often find it purposeless rather than purposive, controverting rather than supporting the principles which we have laid down. This may call for a more careful orientation but does not contradict our explanation of origin and function. As you can not disprove the physiological utility of hunger and appetite by pointing to dyspepsia, nor the use of language by pointing to solecism, so you can not disprove the use of laughter by pointing to its misuse.

If the above explanation of laughter arouses the laughter of the critic who reads these pages, his hilariousness will prove my point, for it will be an expression of his intellectual disapproval and of his personal elation of superiority; and if he does not laugh at it, but takes it seriously, I assume that he has discovered in it some elements of truth which may turn the laugh on rival theories.

SOME PROBLEMS OF PROGRESS

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I

PROGRESS is the controlling idea of western civilization. The man on the street discusses it as much as the philosopher. The most reactionary claims it no less than the radical. It has its place in the campaign material of the politician and comes into the exhortations of the preacher. In fact it is the most widely accepted doctrine of the present day. Yet the state of progress is an accomplished fact only in one of the great divisions of human activity, that is, in science. In the fields of economics and government, for instance, it is only a hope and an expectation. I am not using the term progress in the sense of a sequence of events, not as the state implied by "we don't know where we are going, but we are on our way." I am using it to denote a state of continuous advance with ever increasing rapidity toward an ideal yet definite goal.

The state of change in the field of government or of economics can not be called progressive in the above sense of the term. Great changes have taken place in these fields during the last 150 years, but their character has been impulsive and intermittent, accompanied with backward and forward oscillations. The political history of France from the revolution to the present day is a case in point. Even the history of this country during the same period is no exception. Although reactions comparable with those in France have not occurred in this country, it must be admitted that two of the three great steps towards an ideal of democracy were the result of revolution and of war. The third great step, the extension of suffrage to women, was accomplished by peaceful means, but as a setback we have the constant weakening of the actual if not the theoretical power of the citizen as a voter, which has been going on during the last one hundred years as a result of superficial expansion of democracy without commensurate growth in depth. The lack of simultaneous development of democracy along other lines—principally along economic lines—has introduced into the body politic forces and machinery which have made the franchise as meaningless to the average citizen as the right of a small stockholder to vote in the affairs of a large stock company. The

extension of Hobson's choice by our two-party system is counterbalanced, it is needless to say, by the practical identity of the aims and methods of the major parties.

If we consider any actual event as a necessary and inevitable link in the chain of history, then the present is in advance of the past whatever the character of the present state. Even a long swing backward along the road is a forward stretch if it is unavoidable. If we do not take this fatalistic view, however, it becomes debatable whether we have advanced far, if at all, during the last hundred years in the totality of our theory and practice of democracy, social and economic, as well as political.

The intermittent method of advance in the fields of economics and politics has, in the past, been destructive of wealth, of human lives, of happiness. It has given rise to suppression, revolution and war. It has aroused intense hatred between classes and races. It has produced the misery of filthy slums, on the one hand, and the debauchery of irresponsible wealth, on the other. If this method has been ruinous in the past, it may become fatal, at least to western civilization, if persisted in in the future. This is the supreme lesson to be learned from the last war and from the developments of instruments of destruction. Western civilization is at the parting of the way. It may follow its predecessors in the path of destruction or it may strike out into the new path blazed by science.

The idea of progress is less than three centuries old. It did not become a generally accepted principle until after the middle of the nineteenth century, and even then only in the western world. Its late appearance in the history of civilization is due to the world-wide misconceptions, incompatible with the idea of progress, which prevailed in the past with regard to the origin and destiny of the human race and of its habitat. The Ancient Greeks believed in the cycle theory of civilization. History repeated itself in a series of cycles. Nothing was, or could be, new under the sun. On the other hand, the Christians have followed the Hebrews and earlier oriental peoples in believing in the initial degeneration theory, according to which man and his world were created perfect only a few thousand years ago, but on account of "man's first disobedience" and fall his race and his world were condemned to a relatively short and miserable existence and to a final destruction, except for a chosen few who were to be saved from the wreckage of mankind.

There is no room for the idea of progress in either of these theories. Therefore a reasonable doubt as to their validity was necessary for the birth of the idea, and a more or less complete

overthrow of the theories for its growth and general acceptance. This was accomplished by science. It showed that man has evolved from lower stages of animal life to his present position during a series of geologic periods of immense duration, and that he is likely to exist on the earth for unnumbered generations to come without fear of the world coming to a sudden end. Furthermore, science demonstrated that with his present biological heritage it is possible for man to take great strides with ever increasing rapidity toward understanding nature, formulating her laws, directing her forces and applying them to life. In short, science made it possible for man to cast aside his gloomy outlook of life and his attitude of helplessness, and to take the destinies of his race into his own hands.

But if man is really to control his destiny the state of progress must be more than a hope and an expectation in all of the major fields of human activity. The research spirit, the unbiased critical mind and the experimental method of the scientist must prevail in the fields of politics and economics as well as in science.

But are not the problems of government and of industry very unlike those of science and far more difficult? Nobody can deny the great difference between the problems, but any problem, if it is to be solved, must be analyzed, formulated and eventually solved by the human mind. The general line of approach must, therefore, conform to the fundamental laws of operation of the mind. There is no reason, theoretical or experimental, why the scientific method which has proved equally successful in such varied subjects as astronomy and biology should not yield great results in the fields of government and economics. As to the relative difficulty of the problems no useful purpose is served by a blanket admission, or denial, unless it is followed by a careful analysis of the causes which contribute to the difficulties. It is safe to assert, however, that the greater the difficulty the more forceful is the reason for applying the only general method which has proved to be invariably successful.

II

My object is to point out some of the prevalent theories which are blocking progress in the fields of government and economics (at least as they appear to one scientist), to indicate some of the lessons which we could learn from the history of science, and to outline a plan by which the scientific method might be applied in these fields.

Tradition has been the most formidable enemy of progress in all ages and in every field. Disguised in the latest and most popular fashions it has always worked to arrest progress or to misguide. In the semblance of the guardian of souls, as the custodian of

public morals and safety, in the guises of patriotism, of authority, of loyalty and in many other more or less reasonable attires, it has played havoc with human intelligence. It has been driven out of the domain of science, but in the fields of government, economics and religion it still holds its own. We have heard so much about the conflict of science and religion and so little of any conflict between science and politico-economics. Yet there exists a real conflict between science and the rest, not so much because of differences on specific questions, such as the origin of the world, but because of the incompatibility of tradition with scientific spirit.

Only three centuries ago tradition ruled supreme in science. For two thousand years the western world had looked back with eyes fixed on Aristotle, producing a hypnotic state which made progress wellnigh impossible. Galileo broke the spell by a single crucial experiment. For centuries the world has been taught by tradition that heavier bodies fall faster than light ones. Galileo took a number of balls of different weight to the top of the leaning tower of Pisa and by dropping them showed that they all fell at the same rate. The effect of this simple experiment was startling. It established once for all the experimental method as the supreme test for truth in science.

It is interesting to note in this connection the state of mind which tradition creates. The learned professors of the university of Pisa would not believe their eyes. "Does he think," they said, "that by such experiments he can shake our belief in the true philosophy which teaches us that a hundred-pound ball falls one hundred times faster than a one-pound ball? Such disregard of authority is dangerous." In the light of three hundred years of scientific progress these men appear ridiculous to us. Could we see ourselves in the light of a commensurate progress in politics and economics we might be given to greater charity.

One of the obstacles in the way of progress in economics and government is the prevalent conception of the function of a natural law. As an illustration, consider the statement "the laws of economics are just as immutable as the law of gravitation," which is often used as an argument against any change in our economic organization. To the scientist no law is immutable. However exact our laws may be, they are subject to future revision and extension. Einstein's modification of the law of gravitation is a new evidence of the soundness of this position. The real aim of those who argue the immutability of economic laws, however, is to imply that attempts to alter the conditions under which these laws operate amount to attempting to change or to suspend the laws themselves and consequently are doomed to failure. This is about as sensible as

telling a hydro-electric engineer who is building a canal to divert the waters of a river that he is attempting to suspend gravitation. The law of gravitation operates whatever the condition under which water is made to flow. Similarly the law of demand and supply, for instance, operates under all economic conditions. Whether or not its operation under certain conditions is more conducive to progress than under certain other conditions depends upon the conditions. This question can only be decided by a comparative study of the actual operation of the law under the two conditions and not by arguments regarding the immutability of the law.

Let us take another illustration, this time from the field of government. Chief Justice Taft said in a recent decision, "The Constitution was intended, its very purpose was, to prevent experimentation with the fundamental rights of the individual." I suppose this interpretation is historically correct and justified. The framers of the Constitution were very much impressed by the encroachments on the most elementary rights of the individual by Kings and other government functionaries in the past and wanted to guard against such possibilities in the future by constitutional guarantees. But the problem in this connection has become rather a question of adjustment of the rights of individuals than one of safeguarding them. The time has come therefore to take the position that our conception of individual rights is in the process of growth, that conscious experimentation is one of the factors which should contribute to this growth, and that the constitution should become a guide for and not a barrier against such experimentation.

Again there is a widespread feeling that certain fundamental conditions necessary for progress in government and economics are lacking. This feeling is often expressed by the statements "You can not change human nature" and "change of heart must come first." But are these conditions necessary? Science has shown conclusively that they are not. It is fortunate indeed that they are not. For if progress were conditioned by a change in the nature or in the emotions of man all hope for progress would vanish into thin air. Human nature has not changed appreciably since the stone age. The vast amount of effort expanded during historical time with the explicit object of affecting a change of heart has produced notoriously little result. These conditions are neither necessary nor attainable within a reasonable length of time.

There is a condition, however, which is both necessary and within striking distance, that is a change in the environment, in the atmosphere, in which human nature functions. The civilized gentleman of to-day behaves differently from his ancestors of the

neolithic age because the environment has changed and not because of a change in human nature. The soldier in action with his trench knife in a German dug-out of the western front is not a wild boar using his tusks. He is the same man whom you and I used to know as a fine young man. He has had no change of heart. The stimulii have changed, that's all.

The importance for the future of mankind of a clear understanding of this point can not be exaggerated. By focusing attention upon the improvement of the environment in which his nature functions and upon changing the stimulii which actuate his motives and impel his passions man may achieve in the next four centuries the results which he has vainly striven for during the last forty centuries by trying to change the human heart.

A number of biologists have warned the people of this country of a grave danger which is threatening to lower the hereditary qualities of the American people. They claim with good reason that civilization has upset the processes of natural selection. If this warning is to produce the desired result, however, it must not shift the main emphasis from the improvement of environment to questions of biological selection. The surest and shortest course to the improvement of our biological heritage lies through the betterment of the conditions which make progress possible. We can not afford to confound evolution with progress.

Another fallacy which has impeded progress in all ages is the bugaboo of the danger lurking in the person of the radical. Now, what constitutes a radical? Is he really dangerous in the sense that the general public is made to understand it? In order to obtain answers to these questions which will be free from the prejudices due to the *mores* of any one land or of any one age, we must make a critical study of the history of the radical in all lands and in all ages. If we do this we find, first, that the radical has generally been a man of ideals. His ideals have not always been very high nor his ideas very practical; yet it must be admitted that his radicalism has centered around ideas and ideals. Secondly, that most of the great reformers in religion, in politics, in science (until recently), and, in fact, in all important phases of life have been accused of dangerous radicalism by their contemporaries. Thirdly, that the radical of history has proved to be infinitely less dangerous than the ambitious or the greedy. If there is one supreme lesson to be learned from history, it is the fact that personal ambitions rather than ideas have proved to be disastrous to civilization.

Go through your ancient and modern history and count the number of wars, for instance, which you can conscientiously lay at the door of the radical, and then remember that the inocuous conservative had his share in the few revolutions for which the

radical of history has been responsible. It is decidedly unfair to deprive King George the Third of a small share in the glory of the American war of revolution. It would be interesting and instructive to speculate on the course which the history of the world might have taken had the radicals of Germany in 1848 and those of Russia in the sixties succeeded. Would Carl Schurtz and his friends have proved to be as dangerous as Bismarck and the ex-Kaiser, or Chaikowsky and his "circle" as destructive as the late Czar and his entourage?

One of the most potent factors which has contributed to progress in science is the habit of the scientist to draw general conclusions from carefully considered specific data. This is called the inductive method of science. After finding that two apples plus two apples make four apples and that this rule holds true for rabbits and a number of other objects he arrives at the conclusion that the rule holds for all objects. If a child had to learn the addition of each type of objects separately how fast and how far could it progress? Yet man has behaved when confronted with a new idea like such a child, especially when the new idea happened to concern his dominant interest. When philosophy was the dominant interest in Greece Socrates was accused and condemned for "corrupting the youth." At a time when religion was all important in Judea the custodians of public morals arraigned Jesus before Pilate with the charge "We found this fellow perverting the nation." When tradition and authority of the church were considered of supreme import Galileo was sentenced to death for "disregard of authority." "Heresy," "sedition" and "disloyalty" have been the magic words in all history which have set the hangman's noose into action.

We have learned to tolerate differences of opinion on matters of religion, to take a sympathetic attitude toward political refugees from other countries, and even to welcome new ideas in science. But when it comes to questions of economics and industry we draw the line. We discuss the French revolution with equanimity. A mere reference to the American revolution fills us with pride. But when it comes to the Russian revolution the situation is completely changed. We can not see any good in it. We don't want to see anything good come out of it. Questions of transmission of religious control and of political power through heredity do not excite us for we have never believed in khalifates and have settled the question of the divine right of kings. But we can not consider with composure questions of transmission of economic power through inheritance.

This is an age in which economic questions and problems of government affecting economic conditions form the sacred grounds

where one must not trespass. Yet absolute freedom of discussion is far more necessary for progress in economics and government than in science. The scientist can usually put his theoretical solution to the test of experiment. He can often build a model to demonstrate that his solution is practicable. The student of economics and of government is less fortunate. To be conclusive the experiments in his field have to be carried out on a vast scale in the laboratory of life, over which he has little or no control. The economist who works out a solution for the problem of the most efficient organization and operation of the railroads of this country can not build a model of the country with Belascovian detail and show the skeptic that his solution is workable. On account of this handicap, the widest possible opportunity should be open for free discussion of actual as well as proposed solutions of political and economic problems. This is the absolute minimum necessary for any possibility of progress in these fields without recourse to revolution.

Since the world war, many a well meaning person in this country has tried to do away with this minimum on the ground that criticisms of existing conditions and discussions of possible changes are subversive of democracy and consequently unamerican. These persons either do not understand the implications of democracy, or have no confidence in the ability of the people to exercise their constitutional rights. If the people have to be sheltered and protected against contact with new ideas, good or bad, they can not be in a position to govern themselves. Censorship of ideas and true democracy are incompatible and mutually exclusive.

The road of progress ever penetrates into new and unknown territory. Exploring, surveying, blazing, felling trees and clearing the underbrush are just as essential for the extension of the road as laying the foundation and putting on the top dressing of the road in the cleared sections. It serves no useful purpose for those engaged in the later stages of the construction to call the others idlers or destroyers.

Another popular misapprehension which deserves our attention relates to the function of parties in political progress. We are not interested here with the merits of party government compared with other democratic forms of government. Given the party form of government, what is the proper conception of the function of parties? That is the question which we want to consider. Persons occupying exalted position in one of our major political parties have attacked independent organizations such as the League of Women Voters on the ground that political influence should be exercised only by bodies organized explicitly as political parties.

One might just as well claim that all research and education in the theory and application of electricity must be carried on through duly incorporated electrical companies, preferably through the Westinghouse and the General Electric companies. Electrical stock companies are organized for the express purpose of making money for their owners and not to carry on research and educational work. Their function is to supply the country with electrical machinery. If they do a little research work it is only to keep one step ahead of their competitors. Education means to them the training of the public to buy their wares. The main body of research in electricity has been carried on in the study room of the mathematical physicist and in the laboratory of the experimental physicist. Education has been and will always be the work of non-money-making institutions. The situation in government is analogous. The object of parties is to win political campaigns. Their function is to administer the country in the way the majority of the people think it should be administered. No party is qualified, or can afford, to carry on research necessary for political progress, or to teach the public the results of recent researches. Political education and research work in government must be carried on, as we are now organized, by individuals and by non-partisan organizations, if we are to have progress in this field.

III

So far our discussion has centered mainly upon the contrast between the spirit and attitude which prevails in science, on the one hand, and in politico-economics, on the other. We will now consider the scientific method of progress and see in what way it might be applied to questions of government and economics.

The scientific method of progress consists of two complementary processes. In one of the processes facts, collected through experience, observation and experiment, are used to obtain relations among measurable magnitudes such as length, time intervals, forces, etc. These relations are then assembled into an ideal structure. Geometry and the science of electrodynamics are examples of such ideal structures. In the second process these ideal relations become guides for the proper handling of known data and for the discovery of new facts and relationships. The first is the process of the building up of a theoretical system; the second is the process of the application of the theory. The two together form the wheels upon which science progresses. Without theory practice reduces to the rule of thumb. Without the facts obtained by practice theory becomes unmanageable.

There are two important details connected with the scientific method which deserve special mention. First, the scientist defines

as clearly and unambiguously as he possibly can every word which represents an important concept. Secondly, as his ideal structure grows by the discovery of new facts and relationships, he takes scrupulous care to make it more stable and harmonious by rearranging, by altering and, if necessary, by discarding certain parts.

The work of the students of the foundations of geometry of the nineteenth century and Einstein's achievements are examples of how the scientist searches even the deepest and most solid parts of the foundations of his ideal system for flaws, for weak points, for incongruities. For 2,500 years Euclidian geometry had stood the test of experiment and of the strictest logical thinking of the greatest human minds. Yet the geometrician was not satisfied. Is the postulate of parallelism an independent assumption or is it a consequence of the other axioms of geometry? That was the question which he asked relentlessly and for which he finally obtained an answer that brought with it new systems of geometry. The Newtonian conceptions of space and time formed the solid foundation of the marvelous structure which science has erected during the last three centuries. Yet Einstein asked himself "Are these conceptions of space and time true to nature?" and found an answer which opened a new world for science and philosophy.

In the fields of economics and government there is nothing comparable with the two complementary processes which form the scientific method. There is too much operation in these fields, and too little science, too much of carpentry and too little of geometry, too many operators of electrical machinery and too few who understand electrodynamics. Students of government and of economics appear to be more interested in the operation of the present machinery of organization than in the creation of new and more efficient machinery, or in the building up of an ideal structure with which existing organizations could be compared.

Have the students of the foundations of government (if such exist) examined the famous trio of liberty, equality and fraternity to see whether these foundations of democracy are compatible with each other and with nature, or whether the traditions, the laws and the conventions of democracy are in consonance with its basic principles? Is it possible to have both liberty and fraternity? Is there equality in nature? In what way should liberty be defined so as to bring it into harmony with the responsibilities and the consequent constraints implied by the postulate of the brotherhood of man? How should democracy be organized so as to satisfy the aspirations of man expressed in the term "equality?"

The foregoing questions could be answered and a scientific

theory of democracy could be developed if a group of brilliant scientists could be induced to devote ten years of their lives to the study of democracy in government and in industry, and if they could be organized for concerted effort. The group would have the following objectives.

First: To discover and to formulate a set of postulates, or principles, which are necessary and sufficient for the building up of a theory of democracy, having regard to the adaptability of the theory to life and of the postulates to the theory.

Second: To erect upon the postulates adopted as foundations the theoretical structure of an ideal democracy which will be rational and self consistent.

Third: To draw up a working plan by which our actual democracy could be approached by successive approximations to the ideal, say, during the next one hundred years.

The experts working for the first objective would be mainly mathematicians trained in the foundations of geometry and logicians like Bertrand Russell. The group drawing up the working plan would contain natural scientists, engineers, psychologists, economists and men of practical experience in government and industry. The group working for the second objective would contain all types of experts.

I do not want to give the impression that the foundations and the superstructure of the theoretical democracy and the plan for its materialization could be final. For a scientist finality has no meaning. The theory as well as the working plan would be modified and improved constantly in the light of new experience. Yet I am confident that even the first draft of the theory would be a good enough model for the irrational and inefficient existing systems to copy. Nor am I under the illusion that there is a moderate chance of the working plan being adopted by any country. The usefulness of the scheme which I am proposing would be increased if the plan could be adopted. Beyond that the question of its adoption is not relevant to the scheme. Most of the researches in mathematics and in natural sciences are carried on with little or no expectation of practical application. Some of the most useful applications of science to industry have come about indirectly from researches which had appeared to have no possibilities of practical application. The most useful engine ever invented is Carnot's ideal engine which can not be constructed except in idea. If direct application were the deciding factor in the development of mathematics and of natural sciences we should still be savages. The scheme I have suggested would have its greatest usefulness through its indirect reflection upon society.

BACOT, A MARTYR TO SCIENCE

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ABOVE one of the portals in Memorial Hall at Yale is the inscription, "We who must live salute you who have found strength to die." This sentiment is dedicated to those students who gave their lives on the battle field for their country. No village or hamlet in this or any other country is too small to have a monument to its soldier dead. Romance, fearless heroism and tender memories crystallize out of wholesale human combat. But there have been other struggles which have claimed their share of human interest—spiritual contests, strife against fear and superstition and struggles against disease and pestilence.

The advance of civilization has been made quite as often by individual effort as by group endeavor. In the history of progress in medicine we have countless instances of men who have unselfishly spent their efforts in study and tireless experimentations for the advancement of knowledge. And then we have those selfless souls who have given not only their efforts but their lives in the struggle for mastery over ignorance and disease.

The story of the conquest of yellow fever must always bring to mind the brave group of army surgeons who carried on their experiments among the mosquito-infested swamps of Cuba immediately after the Spanish-American war. One of the men, Dr. Jesse W. Lazear, died with yellow fever, contracted through the bite of a stray infected mosquito which he refrained from killing in order to study its method of attack and because he feared to disturb the patient on whom he was working. That fact is stranger than fiction is brought home to us again in the account of the discovery that Rocky Mountain fever is transmitted from one animal to another by ticks. Through the brilliant work of Dr. H. T. Ricketts we now know that at times the adult tick accidentally bites man, thus causing spotted fever. After isolating the organism responsible for this disease, Ricketts turned his attention to typhus and discovered that this affection also was transmitted by an insect. It was while pursuing this work in Mexico that he was stricken with typhus and died. Both Lazear and Ricketts were fully aware of the virulence of the disease they were

studying, yet neither hesitated in his attack on the unknown. The fact that these men fought an intangible and elusive but none the less deadly enemy with the instruments of the laboratory and finally gained a victory for human welfare entitles them to a place among the heroes whose praises are seldom sung but upon whose achievements the comparative comfort and safety of our present life so largely rests. It is the account of the latest of these martyrs of science to which I wish to refer.

The British medical news dispatches have recently reported the death on April 12th of Arthur William Bacot in Cairo. In January, 1922, he had gone at the invitation of the Egyptian government to carry on further investigations on typhus, not as a result of a serious outbreak of the disease, but in an effort to obtain more definite information about it for preventive measures. Mr. Bacot contracted typhus while handling infected lice. The career of this professional-layman who has contributed so much to our knowledge of insect-borne diseases is worthy of special notice.

Until 1910 he was a clerk in London. On Saturday afternoons and on Sundays he crept away from his drudgery out of the city into the country and pursued the study of entomology with passionate zeal. Apparently he developed his powers for careful, detailed observation on these week-end trips, for one of his early discoveries was that the eggs of gnats will not hatch in absolutely clean water. He became known as an expert on the Lepidoptera and published accounts of his remarkable experiments upon the breeding of moths. In all of this early work there was shown evidence of a skill and fineness of technic which was to be useful to him in his later work; and the enthusiasm and freshness of outlook of the amateur became so firmly developed that his later professional entomological work was uniquely characterized by these very qualities.

Until he was past the prime of life, science was his avocation. In 1910 came his first commission of a professional nature when he assisted in the study of the bionomics of fleas for the Indian Plague Commission under the auspices of the Lister Institute. As a result of his excellent work, he was appointed to the post of entomologist of the Lister Institute, an advancement which was more than justified by his subsequent achievements.

During the next three years he played an important part in discovering the mechanism by which the plague is conveyed from rats to man by fleas. Then he went to West Africa and studied yellow fever, writing a masterful report on the bionomics of the mosquito responsible for its transmission. It is significant that he should make a distinct further advance to our knowledge of the

etiology of this disease, a subject to which American investigators have contributed much and in connection with which another martyr, Dr. Lazear, gave his life more than ten years before.

Since 1916 Mr. Bacot had focussed his attention on the biology of the louse. With remarkable attention to detail he has given us an account of the growth and moulting of the louse, length of life, method of ovulation, feeding habits, effect of temperature and food supply on activity—in short, a complete compilation of the bionomics of this insect. While these studies were in progress the experimental animals had to be fed and, since the natural habitat is the clothing next to the human skin with blood as their food, it devolved on Bacot to devise methods for keeping these lice in captivity and at the same time to feed them. During these and subsequent years he kept his colonies of stock lice in small, round cardboard boxes, one end of which was covered with chiffon so that when occasion arose, the boxes could be fastened on his arms, legs or body and the lice given opportunity to feed. Mr. Bacot realized that many insecticides were not subjected to practical tests before being advocated for use, for that which was effective in the atmosphere of a closed bell jar in a laboratory might be absolutely useless when applied under the clothing next to a moist skin at 85°. He planned and carried out experiments testing insecticides, the lice and the substance to be tested being suspended in cloth bags under his shirt next to his skin. To read, in his own words, of the matter-of-fact way in which he considered these unusual procedures is to have an insight into a type of personality which relegates self to the background and considers steadfastly the final goal of its efforts. Here, in truth, was an effective union of mind and body in service to mankind.

These studies prepared him for similar work of a more specialized nature, and in 1917 the War Office saw fit to put him on the committee for investigating trench fever. This disease had been playing havoc among the British troops. It was reported that at one time 60 per cent. of all the cases of sickness were those due to trench fever. According to another report, it caused nine tenths of all the sickness in one of the British armies. The incubation time of the organism, determined later by experiment, varies from fourteen to thirty-two days. The victim is suddenly seized with dizziness, pain in the legs, headache and pain behind the eyes while his temperature rises to 103 or 104 degrees. Skin manifestations may occur as erythematous patches. The first attack may last a week, then subside only to appear as a relapsing type at intervals of a week or more, each attack lasting from two to eight or more days. The fever may persist for as long as sixty

days with a moderately high temperature. Although the disease is rarely fatal, it is obvious that even a moderate prevalence would seriously handicap military operations.

Through the efforts of Bacot and his associates on the trench fever committee, the mystery surrounding the etiology of this affection has been cleared up. It was shown that the malady was louse-borne, that lack of opportunity to change clothing and uncertain bathing facilities incident to field conditions contributed to its spread, that a louse which had bitten a victim was capable of transmitting the disease to another person through its bite, that inoculation could be obtained by rubbing the feces or body tissues of the louse into a broken surface (as might be done in scratching), and that the dried urine of the victim was infectious. In addition, Bacot showed that in the intestinal tract and feces of lice capable of transmitting trench fever there occurred cocco-bacilli-like bodies, not stainable by the ordinary bacteriological methods, but which were similar to the rickettsia of Rocky Mountain fever. He later decided that the rickettsia of trench fever were identical with those seen in cases of relapsing fever. Such clear-cut evidence, pointing the way to very definite methods of combatting this affection, was particularly welcome at this time of stress and established Bacot in the front rank of medical entomologists, though he was not trained in medicine.

In 1920 he went to Poland as a member of the Typhus Research Commission of the League of Red Cross Societies. He took his own supply of uninfected lice which he had bred and grown in his London laboratory and which he maintained on his own person. After arriving in Warsaw several months were lost due to lack of laboratory facilities. Before active work on typhus was begun, Bacot fell sick with trench fever. During the course of his illness he kept accurate notes of his symptoms and fed lice with his blood. He observed the appearance of rickettsia in his stock lice which until his sickness had been free from them. During his convalescence and for some time afterwards, he followed the occurrence of rickettsia in the lice which he had fed and was able to show that the blood of trench fever patients when fed to lice caused the appearance of these bacteroid bodies in the lice as long as three months following the clinical recovery from the disease.

After returning to England Bacot continued his studies on infection of lice. Late in 1921, before the Royal Society of Medicine, he gave a demonstration of a method for louse infection. The procedure involved the rectal injection of blood into the louse with a capillary pipette while the insect was held under a slip of paper on the stage of a binocular microscope. All who saw it were im-

pressed by the skillful technic and dexterity shown by Bacot during the course of the demonstration. Working with these minute animals, using specially devised microtechnic, Bacot fully realized the dangers to which he was exposed because of the infectious character of the excreta of the lice, once they had fed on typhus blood. These facts serve to emphasize the high order of purpose and intensify the sacrifice he made.

An American architect recently said that the English really know how to live. If they know how to live, they also know how to play and many of them have achieved that happy combination—the proper relation of their vocation to their avocation. The typical Briton works at his stint that he may support his hobby and it is in the pursuit of the latter that he lives his life, expands his soul and produces. In the personality of Mr. Bacot we have an example of just such a balance between that which must be done and that which pleases to be done. His hobby became his ruling passion, gradually absorbed his whole life, lifted him to eminence and finally placed him among the immortals—those who have given their best that others may better live.

MODERN STUDY OF THE ATOM

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PRINCETON UNIVERSITY

Reality of Atoms and Molecules

In the latter part of the last century many distinguished men of science still doubted that reality underlay the atomic and kinetic theories and therefore preferred to deal with chemical phenomena mainly from the standpoint of energy changes. Chief among these prophets of the energetic school was Wilhelm Ostwald. After working over the material for the new edition of his "Outlines of General Chemistry," however, Ostwald wrote in 1908: "I am now convinced that we have recently become possessed of experimental evidence of the discrete or grained structure of matter, which the atomic hypothesis sought in vain for hundreds and thousands of years. The isolation and counting of gas ions, on the one hand, which have crowned with success the long and brilliant researches of J. J. Thomson, and, on the other, the agreement of the Brownian movements with the requirements of the kinetic hypothesis, established by many investigators and most conclusively by J. Perrin, justify the most cautious scientist in now speaking of the experimental proof of the atomic structure of matter." When, therefore, even the foremost protagonist of the energetic school has come into the ranks of the atomists, there can now be little doubt that the evidence points to the reality of atoms and molecules, at least in the minds of those who are competent to judge. It may be added that much new evidence has accumulated since Ostwald wrote in 1908. We may, therefore, consider that the ground has been cleared of that type of obstructor who denies the existence of atoms other than as figments of the imagination.

In what follows I wish to present, for the benefit chiefly of those who have not had opportunity to follow the literature of the subject, a picture of the atom as we envisage it to-day. To do this most briefly, one can not in everything follow the historical development of the last thirty years. It is quicker, and often clearer, to give results first with supporting evidence afterwards, to employ a deductive as well as an inductive method.

THE PRESENT-DAY ATOM

Let me, therefore, say at once, and, for brevity, in a very didactic manner, that atoms are built up of two and only two kinds of building materials, bricks, or units of construction, namely protons and electrons. Under like conditions, all protons are alike and all electrons are alike. The chief attributes of these protons and electrons may be simply tabulated thus:

	MASS (AT REST)	ELECTRIC CHARGE	DIAMETER IN CM.
Electron	1/1845	—1	3.8×10^{-13}
Proton	1	+1	2×10^{-16}

The hydrogen atom consists of one proton and one electron. The unit of mass here employed is a mass 1/1846th part less than that of the hydrogen atom itself. The precise value of this mass in grams does not here interest us any more than does the precise value of the unit electric charge expressed in terms of the conventional electrostatic units.

Every atom consists of a positively charged nucleus in which is concentrated nearly all the mass of the atom, and this nucleus is surrounded by a number of electrons sufficient to neutralize the nuclear charge. The atom as a whole is, of course, electrically neutral. For hydrogen, the positive nucleus consists of but one proton; but, in all other atoms, the positive nucleus contains what are called intranuclear electrons as well as protons. The value of the net positive charge on the nucleus of any particular type of atom is equal to the atomic number of the atom, that is, the ordinal number the atom would receive if all our 92 elements were numbered in order of increasing atomic weight, or, better, because of the three standard disorderly cases of potassium-argon, nickel-cobalt and iodine-tellurium, in order of rank in the periodic tabulation of the elements. The roll of the chemical elements, as we shall see, was called first, if incompletely, by one Moseley in 1914, and, of the 92 now on the roll, five elements are yet absent. The number of extranuclear or planetary electrons in chemical atoms, therefore, runs from 1 for hydrogen, 2 for helium, 3 for lithium, etc., up to 92 for uranium, the heaviest atom not yet extinct. The number of planetary electrons is the same as the atomic number of the atom.

The outside diameter of atoms is of the order of 1 to 5×10^{-8} cm., or 100,000 times the diameter of the electron, so that it is evident that the spacing of the nucleus and extranuclear electrons in an atom is a very open one, more so than in our solar system, in which, also, our central sun is inordinately large for true relative dimensions. So far as the volumes of the discrete structural units, pro-

tons and electrons, are concerned, therefore, atoms are filled chiefly with emptiness or void. Granting that the planetary electrons are so few in number, never over 92, and so light in weight, it is obvious that, as has been said, the main mass of the atom must be concentrated in its nucleus. To illustrate the make-up of an atomic nucleus, consider, for example, the case of the atom of fluorine. Its atomic weight is about 19. Therefore its nucleus must contain 19 protons, which would furnish a positive charge of +19. But its atomic number is 9, and hence its nuclear charge is +9. To reduce a positive charge of 19 to 9 will require the presence of 10 electrons in the nucleus, ten negative units of electrostatic charge thus offsetting ten of the positive units.

As regards the picture of the atom developed so far, there is much unanimity. The kind of questions not yet solved are those about the detailed constitution of the nucleus, and the arrangement of the extranuclear electrons. Further study might therefore be divided into (1) study of the nucleus and its constitution, and (2) study of the extranuclear portion of the atom and its possible arrangements of electrons, with the orbits or oscillations in which they are engaged. But we shall not follow this program.

Having placed before you a broad idea of the present-day conception of the structure of atoms, I wish now to go back and look at some of the methods of study that have led to the knowledge we have gained.

Electrons and Protons

Our knowledge of the electron has been reached chiefly through a study of the discharge of electricity through gases, with which the name of Sir J. J. Thomson is so closely associated. We should not forget, however, that, as early as the seventies of last century, Sir William Crookes observed streamers of light emerging from the cathode of highly evacuated discharge tubes. These he considered were composed of matter in a new, fourth state which he called "radiant matter." Certain German investigators thought the streamers were due rather to an ether wave motion analogous to light. It was not till 1895 that Sir J. J. Thomson showed that Crookes had been correct. The cathode rays are now known to consist of streams of swiftly moving electrons. Like any other particles that carry a charge, these electrons are deflected from a straight line course by either a magnetic or an electrostatic field properly applied, and, by using known field strengths of both kinds and measuring the resulting deflections of the electrons, the relation e/m between their charge and their mass can be ascertained. This is a method of measurement of very fundamental importance. Very high speed electrons of different, definite speeds are ejected

by certain "radioactive" atoms at the moment when such atoms break up, and a study of e/m for these electrons has shown that, if the charge is the same, the apparent mass increases with the measured speed of the electrons in a manner that harmonizes precisely with what would be anticipated on theoretical grounds if their mass were entirely what is called electromagnetic, or entirely due to their charge. Knowing that the mass of an electron is entirely electromagnetic in origin, we can then, assuming a spherical form, calculate by electromagnetic rules its radius, which comes out with the value noted above.

Individual electrons have been isolated by Millikan and others, and their charge evaluated precisely in electrostatic units. No electric charge that was a fractional part of that of an electron was ever encountered in this work, but only whole number multiples of it. From this it appears that negative electricity comes in small unit amounts or grains, like pepper. In other words, negative electricity, like matter, is atomic. At present we know less about the proton, or unit positive charge, than about the electron; its much greater mass, if electromagnetic, gives it a correspondingly smaller radius, as noted above, because, for the same charge on a spherical surface, electromagnetic mass varies inversely as the radius of the sphere.

Origin of X-Rays

The electrons in a discharge tube, such as an X-ray bulb, can be made to move with very high speeds, and so to carry much energy. They are stopped abruptly by striking the atoms that constitute the target in the bulb, and, by transferring some of their own energy, stimulate radiation of short wave light on the part of certain of the extranuclear electrons belonging to these atoms. They likewise themselves emit general wave radiation as they slow down. The very existence of these so-called X-rays, emerging from such targets, was not observed until 1896, and they were not known to consist merely of short wave length light until 1912.

X-Rays and Crystal Structure

I may remind you that one of the most successful methods of studying and analyzing common light is by means of a Rowland diffraction grating, which consists of a large number of fine lines ruled exceedingly closely together on a transparent or else reflecting surface. Such a grating will perform its analytical function only provided the ruling or grating space is sufficiently close compared with the wave length of the light being tested. A picket fence is a possible Rowland grating, but is far too coarse to give

useful results. So likewise a real Rowland grating is far too coarse to give appreciable diffraction of X-rays, because these are of such short wave length. In 1912 it occurred to the Swiss Laue that in ordinary crystalline substances we have ready-made very minutely spaced diffraction gratings, of skeletal type, indeed, and in three instead of only two dimensions of space. Stated otherwise, he thought the atoms of which the crystal is built might furnish centers to diffract the X-ray light, and these atoms are already arranged by Nature in rank, file and column with perfect regularity and with the requisite close spacing. Laue's expectations were brilliantly fulfilled, and the method has been developed by the Braggs in England, by Dr. Hull at Schenectady and by many others.

Because it is based on a relationship between the spacing of the layers of atoms and the wave length of the light diffracted by them, this powerful modern method of analysis may be employed in either of two ways, namely, to study (a) either the light wave length or (b) the spacing of the atoms. A single relationship connects these two unknowns. To get a value to start from, the atomic spacing in, say, sodium chloride can be computed from the known number and plausible crystallographic arrangement of atoms in one cubic centimeter of crystalline salt. Hence we can find the wave length of some particular easily-generated monochromatic X-ray light, which we can thenceforth use conveniently as our yard-stick in measuring atomic spacings in other crystals.

Results from the X-Ray Spectrometer

(a). Moseley in 1914 tried many different elements as targets in the X-ray bulb, analyzed the resulting X-rays by means of a crystal, and found that each element emitted general X-radiation, but also its own characteristic sets of X-rays of but a few kinds, that is, each element emitted a characteristic X-ray spectrum, consisting of but a few spectral lines peculiar to the element. Selecting a particular type of emitted light (K, L, etc., series) for making comparisons amongst the elements, Moseley arrived at the remarkable result that the square roots of the wave frequencies varied in progressive stepwise fashion from element to element, giving a series of equal whole-number steps that would, if complete, run approximately from 1 for hydrogen to 92 for uranium, just as the atomic numbers do. Any missing step was conspicuous, and indicated clearly an element lacking. From this we have learned that we must search for just five new elements, and that we must adjust our atomic numbers to allow for the elements that are missing.

It may here be remarked that the ordinary old style light spectra emitted by the chemical elements in the flame, arc, spark, sun or stars are of much more complex character than these simpler X-ray spectra. The latter give us information in regard to those extranuclear electrons which, after suffering displacement, gain positions of stability nearest to the nucleus; while the former longer wave light spectra inform us of the relatively slower radiations of those electrons that reach stations of stability in the outer regions of the atom. Within the last few years, both types of spectra have been so extended as to overlap, and the former outstanding gap of four octaves of light frequency has been completely bridged.

(b). The distances apart of layers of atoms in crystals are of an order smaller than one millionth of an inch. Small as are these distances, however, they are measurable by the X-ray spectrometer with an accuracy much better than one hundredth of one per cent. Given the crystallographic data of a crystal and its atomic arrangement, one may, by assuming the atomic weights of the constituent atoms, determine the density of the crystal by X-ray analysis with an accuracy superior to that of the more usual older methods. Conversely, if the density of the crystal is known, but the atomic weight of one of the constituent atoms is unknown, this may similarly be determined. Of greater interest, however, is the employment of the X-ray spectrometer to determine the arrangement of the atoms in a crystal. This can be done with a good deal of assurance for crystals belonging to the crystallographic systems of higher symmetry. Simple substances, such as the pure metals, usually crystallize in such systems, and have been subjects of fruitful study. Especially interesting to the organic chemist is the crystal lattice of diamond, in which each carbon atom is surrounded by four others at equal distances from it and in the directions of the four corners of a tetrahedron from its center of gravity. It has heretofore been tacitly assumed that the nuclei of the atoms in the crystal acted as simple point centers for diffracting light; but closer study reveals evidence of the position of certain extranuclear electrons which are in all probability those that constitute the valence bonds of the carbon. It is further apparent that these valence electrons, if not stationary, at least patrol stations other than the nucleus. This is confirmatory of the Lewis-Langmuir theory of atomic structure, to be mentioned shortly. Of even greater interest to the organic chemist are the recent studies by means of the X-ray spectrometer of the possible arrangement of the atoms in naphthalene, anthracene and allied substances. Viewed from one standpoint, the carbon atoms in

diamond lie at the corners of hexagons bent at their corners so as to fit on puckered surfaces, or surfaces composed of V-like corrugations like galvanized roofing without rounded bends. In spite of its different crystalline form, very different hardness, etc., graphite, the other crystalline form of carbon, exhibits an identical arrangement of carbon atoms in puckered hexagonal formation, but with the planes containing the hexagons further apart. Assumption of this same corrugated hexagonal structure, which appears so favorable for carbon atoms, satisfies the experimental results obtained with crystals of naphthalene in the X-ray spectrometer. One can not say that the organic chemist's customary graphic formula for naphthalene and its allies has been independently proved correct; but it has at least been shown that this time-honored formula is in complete harmony with the new experimental facts.

Arrangement of Extranuclear Electrons in Atoms

Passing from the arrangement of atoms in molecules to the arrangement of the extranuclear or planetary electrons in individual atoms, we reach a field where the experimental facts, chemical or spectroscopic, are more difficult of present interpretation, and where, at present, we are largely being guided and, I should add, stimulated by hypothesis. The hypothesis at present most acceptable to the chemist, doubtless because it was designed to fit the chemical rather than the spectroscopic facts, is that of Lewis and Langmuir; and this may be most easily visualized by the aid of models of atoms. Here we have the electrons patrolling definitely localized stations which are arranged in concentric shells round the nucleus. Similarity in number and arrangement of stations in the outermost shell makes for similarity of chemical properties, and so accounts for the well-known family resemblances of a chemical kind among the atoms. Furthermore, for many of the commoner atoms at least, the number of electrons in the outermost shell that gives the greatest stability is, on this "octet" theory, eight. If we personified such atoms, their chief ideal in life would be to secure, by hook or crook, an outside shell of precisely eight electrons; and this ideal motivates all the chemical reactions of such atoms. The two possible mechanisms by which the octet ideal is achieved are by reciprocal lending and borrowing or else by sharing electrons, corresponding to the conceptions of electrovalence and covalence, respectively. Atoms that already have eight electrons in their outer shells, like neon and argon, have no motive for any chemical action, and, as is well known, are entirely inert. By these new conceptions of valence, certain molecular structures are anticipated to be closely similar (isosteric) which

would be entirely dissimilar according to the older ideas of valence; and the close similarity of crystal form (isomorphism) actually observed in many such cases, a stumbling block and even a reproach to the chemical crystallographers of but ten years ago, strongly confirms the correctness of the newer views in these instances.

Less interested in the chemistry of the atoms, Bohr and his followers have been more concerned in devising an atomic model that will explain the kinds of energy radiated by an atom as light when one of its extranuclear electrons falls from a location of higher to one of lower potential energy, this light having a frequency which depends not on the final environment reached by the electron but rather on the energy made available by the fall. This theory is brilliantly successful, but hitherto only in the two simplest cases. If the planetary electrons all revolve in simple ellipses round the nucleus, there is insufficient localization of fields of force around the atom to satisfy the valence demands of the chemist, even although the orbits be not in the same plane. To me, the possibility of twisted or looped orbits round the nucleus would offer more satisfaction; as also would a complex electron to account for the facts of radiation.

Because both these types of hypothesis as to the arrangement and activities of the extranuclear electrons are at present in a somewhat speculative stage, I prefer to pass on to tell of other matters closer to the facts reached by the modern methods of study.

Spontaneous Disintegration of Atoms: Isotopes

All of our atoms of atomic weight over 206 are observed to have the proclivity to disintegrate. The nucleus of the atom of Uranium-1, for example, has a mass about 238 and a charge of +92. Occasionally, such an atomic nucleus, for cause utterly unknown, suffers a cataclysm in which the nucleus of a helium atom is expelled with enormous speed. (A helium atom consists of a minute nucleus built of 4 protons bound together by 2 electrons, which is surrounded by two planetary electrons). This expelled portion, endowed with terrific energy of motion, is called an alpha-particle. Because it lacks the two planetary electrons of the helium atom, it bears a double positive charge, and the moving alpha-particle can therefore be studied in the magnetic and electrostatic fields and the ratio measured of its charge to its mass, by which measurement its nature was divulged. On picking up two planetary electrons the alpha-particle becomes a helium atom. The precise volume has been measured of helium gas generated in this wise from radioactive material ejecting alpha-particles in numbers that can be counted one by one, and so has been enumerated directly

the number of helium atoms per cubic centimeter of the helium gas collected.

After throwing out its alpha-particle, the residual portion of the Uranium-1 atom, having lost 4 protons, possesses a mass 234 instead of 238. It has lost from its nucleus also 2 electrons, and therefore a net charge of (4—2) or +2. Its atomic number is thus smaller by 2, that is 90, and its ordinal position in the periodic table is two places below and to the left of Uranium-1. It is, in fact, a new element, named Uranium-X_1, which resembles the element Thorium. But it is a short-lived element, and soon expels from its nucleus an electron, or beta-particle, yielding a residual product, called Uranium-X_2, of the same atomic weight 234, but of atomic number 91. This disrupts with loss of another beta- particle even sooner than the last, producing the atom of an element, called Uranium-2, of atomic weight still 234, but of atomic number 92. But 92 is the atomic number of Uranium-1 from which we started. Thus Uranium-1 and Uranium-2 have the same nuclear charge, +92, and must have the same arrangement of extranuclear electrons, for this is ordered by the nuclear charge, and not appreciably by the nuclear mass. Thus, the outsides of U-1 and U-2 will be identical, and on the outside of an atom do its chemical properties depend. Consequently, U-1 and U-2, falling in the same ordinal position in the periodic system, are identical chemically and therefore inseparable by chemical means. Such elements are called isotopes. They have the same nuclear charge. Elements with the same nuclear mass are called isobars, as U-X_1, U-X_2, and U-2.

After a chain of successive disintegrations involving losses of 8 and 6 alpha-particles (mass 4) respectively, both uranium (mass 238) and thorium (mass 232) produce atoms with the nuclear charge of lead. On account of their different parentage, however, these two types of lead atoms would be expected to have masses of 206 and 208 respectively. They have each been isolated, from uranium and thorium minerals respectively, and found to possess atomic masses closely as expected.

Most of the known radioactive or spontaneously disintegrating elements have atomic weights of 206 or over. But rubidium and potassium are also radioactive, as are one of the constituents of common brass and also the metal platinum, although these latter atomic species disintegrate at an exceedingly slow speed and emit alpha-particles so lacking in energy that they are difficult to detect. There is no reason why the habit of disintegration should not be general among elements. In any case, we are clear that isotopic atoms, whether formed in a process of disintegration or in

a process of evolution, should be identical chemically, and so, like birds of a feather, should be found together. The question then arises, how many of our elements are mixtures of isotopes, indistinguishable by chemical difference? The question can be answered only by physical methods. If the isotopes are heterobaric, of different mass, then they can be identified and separated because of their difference in mass. Speed of diffusion or of free evaporation depends on mass, and so the elements mercury and chlorine have both been shown to consist of mixtures of heterobaric isotopes.

The Mass Spectrograph

But the most fertile method yet employed to recognize heterobaric isotopes is that devised by Sir J. J. Thomson, depending on the fundamental fact, already mentioned above, that different values of the ratio charge to mass of a charged particle moving in a high vacuum will give rise to different degrees of deflection in the magnetic and electrostatic fields. A gas or vapor particle containing the element under investigation is therefore given a positive charge in the discharge tube, and its resulting deflection is studied. Such a particle may acquire more than one unit charge, but such multiple charges cause no confusion. Refinement of this beautiful method in the hands chiefly of Aston has shown us that the elements Li, B, Ne, Mg, Si, Cl, A, K, Ca, Ni, Zn, Br, Kr, Rb, Sn, Xe, Hg, are all, at least as we have them ordinarily available on this planet, mixtures of isotopes; whereas H, He, Be, C, N, O, F, Na, P, As, I, and Cs have been studied and proved simple. Published results on no others are yet available. Only those elements which can readily be obtained in stable gaseous form have yet been investigated; but as soon as any of the less volatile elements or their compounds are obtained in suitable gas form, additional results of interest will be forthcoming. Because his measurements in the mass spectrograph of the masses of most atoms had an accuracy of 0.1 per cent., Aston was enabled to discover that the atomic weights of the chemical elements investigated, save hydrogen, are invariably whole numbers on the scale oxygen=16, to the degree of accuracy mentioned. The fractional value 35.46 found by chemical analysis for chlorine, for example, is explained by that element's consisting of certain proportions of two isotopes of masses 35.0 and 37.0 respectively. Thus is the century old hypothesis of Prout, that all atoms have masses that are whole number multiples of the mass of the hydrogen atom, resurrected and rehabilitated, but with a unit of mass almost 0.8 per cent. less than that of the hydrogen atom. Mathematical rigor in this "whole number rule" is, however, not to be expected for a reason that will now be referred to.

A New Possible Source of Cosmical Energy

Hydrogen, in Aston's mass spectrograph, appears to have an atomic mass of 1.008 (0=16), precisely as found by the chemists. Hydrogen, however, is unique among the elements in having no electrons but merely one proton in its nucleus. In all other atomic nuclei there are electrons packed close to the protons, and this close packing of charges of opposite sign is expected, by electrical theory, to influence the electromagnetic mass of the complex by an amount dependent on the closeness of packing. If we could build a helium atom from the materials which are correctly furnished by four hydrogen atoms, there would ensue a loss of mass of about 0.8 per cent., since the atomic weight of helium is 4.00. This mass, however, can not be destroyed, but must appear, according to the relativity theory, as an equivalent amount of energy. The quantity of energy concerned in the transformation of 1 gram of hydrogen to helium, namely 8 milligrams, or about the weight of one fifth of a postage stamp, corresponds to what, as electrical energy at ten cents per kilowatt hour, would cost $20,000.

If such a synthesis of helium from hydrogen may be supposed to be going on in the sun, we have a much needed explanation of the sun's present brightness at his known old age.

Experimental Utilizations of Alpha-particles in Investigation

The alpha-particles expelled from radioactive elements are by far the most energetic entities with which we are yet acquainted. The swifter kinds have, for unit mass, an energy of motion 400 million times greater than that of a rifle bullet. Being helium nuclei without circumambient planetary electrons, they are very small, and readily shoot through atoms, knocking out their extranuclear electrons right and left. The damaged atoms soon pick up other electrons to fill the gaps, and thus suffer no permanent change. Alpha-particles pass through thin glass, leaving no hole. Very occasionally, an alpha-particle will make a bullseye collision with the nucleus of an atom. The consequence of this collision, in the case of nuclei of some light atoms, is that the nucleus struck is disintegrated, with the expulsion of a single, swift-moving proton. The experiment succeeds in the case of B, N, F, Na, Al, and P nuclei. In the case of aluminium, Rutherford found that the single protons expelled have an energy of motion that is 40 per cent. greater than that of the alpha-particle missile that struck the atom. What remains of the aluminium nucleus is still under investigation, but it is permanently changed and is certainly no longer aluminium. Thus, in transmuting an element, we obtain free energy. The alchemists expressed this allegorically when they identified the philosopher's stone, which would transmute metals,

with the elixir of life, a source of ever fresh life or energy. Our enthusiasm for this transmutation is duly restrained by the knowledge that only about two per million alpha-particles make bullseyes on the aluminium nuclei.

In the case of the heavier atoms with their more highly charged nuclei, the alpha-particle, of the speed hitherto at our disposal, apparently loses too much energy in the approach to be able to effect disintegration of the nucleus. Its path is sometimes bent back in a large angle deflection, by an elaborate study of which in the case of gold the existence of the minute, positively charged nucleus of atoms was first established. The nuclear charges of gold, platinum, silver and copper have each been directly evaluated by this method, and agree with the atomic numbers of these atoms to 1 per cent., the known value of the experimental error.

The Duration and Possible Repetitions of Geological Time

The unchanging and, so far as all experiment goes, unchangeable spontaneous disintegration of heavy atomic nuclei has geological interests both in view of the time periods involved and also of the energy emitted in the process. Thorium disintegrates into thorium-lead, which is stable, at a rate which we have been able to ascertain. The "range" or distance travelled through matter by the expelled alpha-particles is strictly related to the rate of the various disintegrations, and such ranges and rates have ever remained constant for thorium and its descendants as evidenced by the constancy of the diameters of the range "halos" surrounding microscopic thorium inclusions in rocks of various ages. The diameters of these halos agree, also, with the ranges in air of the alpha-particles as studied to-day, and so the thorium clock has ever run at the same rate. Some thorium minerals contain lead whose measured atomic weight shows that it has practically all been derived from the decay of thorium atoms. From the ratio of the number of thorium atoms remaining to the number of those originally present, many of which are now represented by lead atoms which they produced, one can compute the age of the mineral, which thus gives a date to early paleozoic times of 150 million years back. Similar calculation from uranium minerals gives a period over 900 million years, but there is reason to believe that the uranium clock formerly ran fast, or, rather, that it appeared to run fast owing to the former presence of a third isotope of uranium, now almost extinct, of speedier rate of decay than what to-day we call U-1.

Rock analysis shows that, assuming percentage composition similar to that on the surface, there is enough radioactive material

in a depth of only 12 miles of the earth's crust to supply by its daily disintegration all the heat the earth radiates daily into space. If an appreciable amount of radioactive material exists below this depth, as seems certain, then heat must slowly be accumulating within the earth's non-conducting crust. Eventually, therefore, if no compensating heat-absorbing process is taking place within, an unstable state will be reached when the underlying incandescent material will perforce evert itself to the exterior and there disburden itself of its accumulated heat by radiation into space at a very rapid rate proportional to the fourth power of the temperature. This is the earth's incandescent epoch. When the crust has cooled down again sufficiently, a new geological epoch of perhaps 200 million years may begin, to be followed in turn by another incandescent epoch, and so on, alternately, but more and more slowly, until the radioactive materials, if not regenerated, have by disintegration lost their available energy. This alternation the Brahmans have symbolized in their cosmogony as the indrawing and outbreathing of the breath of Brahma.

THE PROGRESS OF SCIENCE

CURRENT COMMENT

By Dr. Edwin E. Slosson
Science Service

EVOLUTION WORKING BACKWARD

Once farmers planted the nubbins of their corn and the potatoes that were too small to sell. Now they know better. They cut up their finest potatoes to plant, and every grain of their seed corn is pedigreed as carefully as a Colonial Dame. The result is seen in the doubled yield in potatoes richer in starch and corn richer in protein. Modern agriculture is fertilized by science.

The most backward branch of biology is the infant science of sociology. It is only just beginning to get its eyes open, to see things; in time, perhaps it will be able to do things, like the older sciences. But there is need of haste. The age of instinct is passing, the reign of reason has not come. Man has been pushed up to his present position. He has succeeded in slackening the pressure. Will he go forward rationally, of his own free will, or sink back until again he falls under the sway of the blind and merciless forces of the struggle for existence?

A decrease in the birth rate is not necessarily a misfortune to a country. Very likely, for instance, the British Isles have now all the population they can support in comfort under present economic conditions. The alarming thing about it is that the breeding is from the poorest stock instead of the best. Whatever objective standard one may take this is true. A statistical study of the population of Great Britain showed that in the districts where there was the most overcrowding, the cheapest type of labor, the lowest degree of culture and education, the highest percentage of pauperism and lunacy, the greatest criminality and the highest death rate from tuberculosis and infantile diseases, there the number of children was greatest in proportion to the possibly productive wives. It is a clear case of the survival of the unfittest, the reversal of evolution. No race can maintain its efficiency and virility against such reactive forces.

The future of a country depends ultimately upon the character and ability of its people. Increase of wealth, advance of science, improvement in education, discoveries in sanitation, juster social conditions, all the achievements and hopes of the present age will be of little benefit to posterity if there is a decline in the native quality of the race. It would be disastrous to hand over a more perfect and complicated governmental machine to inferior engineers. One seventh of the present generation will be the parents of one half of the next. Therefore, two generations of selection, natural or designed, would completely transform the character of a nation. Is this seventh composed of the best men and women that we have?

This is what is going to determine whether civilization shall advance or retrograde. Galton's ideal of eugenics may be too much in advance of the age to be practical, but at least something could be done to awaken the people to the imminent dangers of dysgenics.

ATOMS OF LIGHT

The discovery of the X-rays in 1895 acted like the discovery of gold in an unexplored country. It opened the way to the exploration of a field of unsuspected wealth of new knowledge and to the radical reconstruc-

Wide World Photos

PROFESSOR A. L. HERRARA

The distinguished biologist of Mexico, who is visiting the biological institutions of the United States.

tion of some of our time-honored and fundamental conceptions. It opened up to us the atom, the *ne plus ultra* of the chemist, and showed within it a system of revolving bodies far more numerous and complicated than the solar system. Already our knowledge of these electrons, whose existence was unsuspected a few years ago, is greater than our knowledge of the molecules, and we can study them with much more facility because they carry charges of electricity which betray their presence in the minutest number. A single electron can be detected while the smallest number of gas molecules which can be discerned with the spectroscope is about ten million million.

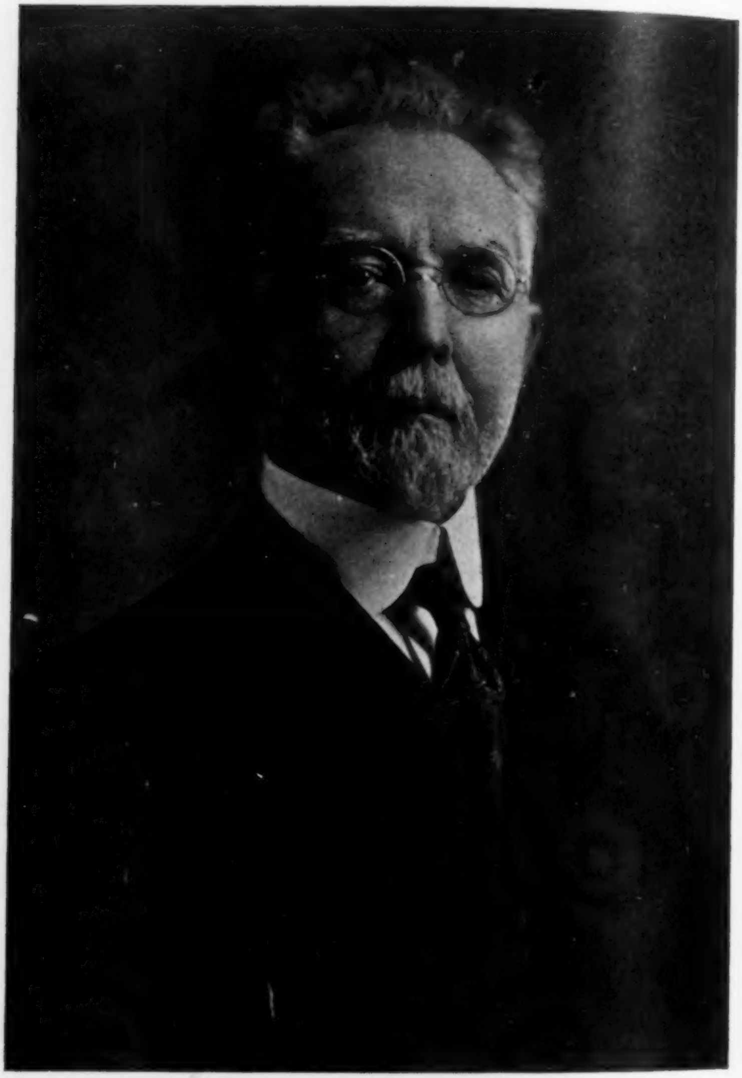
The tendency of the times is to extend the atomic theory into new fields, to speak of atoms of electricity, of energy and of light. The corpuscle, the smallest known particle of negative electricity, is only one seventeen-hundredth the mass of the atom of hydrogen. The smallest unit of positive electricity, on the other hand, seems to be equal to the atom of hydrogen. It is possible, however, that this positive particle may be a complex of many positive and negative particles and that the individual positive corpuscle when isolated as the negative one has been may prove to be equally minute.

The discovery of the enormous stores of energy compact in the atom in the form of the electrostatic potential energy of its negative corpuscles gives one a peculiar sensation. It is like finding out that there is a barrel of gold and a dynamite bomb in the cellar of the house. But a gram of hydrogen would be capable of developing more heat than the burning of thirty-five tons of coal. Since energy is wealth we have everywhere enough to make us all rich "beyond the dreams of avarice" forever, but we have no way of unlocking this storehouse. This may be fortunate for us since Professor J. J. Thomson, of Cambridge, says, "if at any time an appreciable fraction were to get free the earth would explode and become a gaseous nebula." Professor Thomson, in compensation for our natural disappointment at being frightened off these preserves by such a terrifying spring-gun, reminds us that on every sunny acre 7,000 horse-power of radiant energy from our solar dynamo is going to waste and that it is neither impossible nor dangerous to utilize it.

THE LITTLE ENEMIES OF MAN

Early in the history of the human race man learned how to conquer the mastodon. He has yet to learn how to master the microbe. Whales and elephants are now almost extinct, but mice and flies still increase and multiply, and the bacteria, smallest and most dangerous of all, find new ways of attacking us. It is only within the last few years that man has learned which his greatest enemies are, and he has not yet found weapons against them. The explorer in tropical jungles used to fear the lions, tigers and pythons; now he protects himself most carefully against the mosquitoes and tsetse. Mars has afflicted the human race less than Beelzebub.

Although we theoretically accept the conclusion of science that a man's foes are those of his own household, we are not yet aroused to the necessity of waging war in earnest against them. We have a secretary of navy and we give him millions for defense, but we have no secretary of sanitation, though that is a more necessary office. It is quite improbable that any American will be killed by an invading army this year, but our land is invaded by millions of mosquitoes and flies armed with deadly weapons and certain to slaughter thousands. Years of study and experimentation will be necessary before we learn how to fight our insect foes, but already enough has been done to show



Photograph by Harris and Ewing

DR. GEORGE P. MERRILL

Head curator of geology in the United States National Museum, to whom the National Academy of Sciences has awarded the J. Lawrence Smith Medal for his investigations of meteorites.

what can be accomplished if we go about it in the right way. Many of the sanitary measures of the past we now know to be crude, clumsy and misdirected, yet they are fixed in the popular mind and remain on our statute books. People still talk about the dangers of miasma and sewer gas, and think a deodorizer is a disinfectant.

We are far from acting up to our lights. The housewife wages war against vermin, but she does not realize that they are more dangerous than trolley cars. She gets more excited at the discovery of a moth than a fly, although the former only attacks clothing, not its contents. We have drain pipes in our walls to carry off disease, but beside them are conveniently arranged passages by which roaches can carry diseases from flat to flat, so that everybody has a fair chance to catch whatever is going. Our windows are hospitably open to the malarial mosquito and typhoid-bearing fly. Over our clothing on the street cars crawl unmentionable insects carrying unmentionable diseases. In the fashionable hotel and restaurant the napery and porcelain are immaculate and the waiters are scrupulous; what goes on behind the screen and in the market is another story. We have got past the days when we kept the pig in the parlor, but we still keep the dog in the parlor, which is quite as bad. On the street we see the pet dog gnawing a decaying bone and nosing the foulest spot to be found, and a moment later he is cuddled in the arms of his fair and fastidious mistress and licking her cheek. We have yet to realize that it is the dogs which are not mad that are the more dangerous. They injure more people by their kisses than their bites.

In primitive days man had to associate with the lower animals. He needed dogs and horses and he very properly made friends of them. He is now learning how to do without them, and he should, like a snob who has risen in the world, exclude them from his circle of intimates. The house is not intended for a zoological garden. Insects and animals may be our worst enemies.

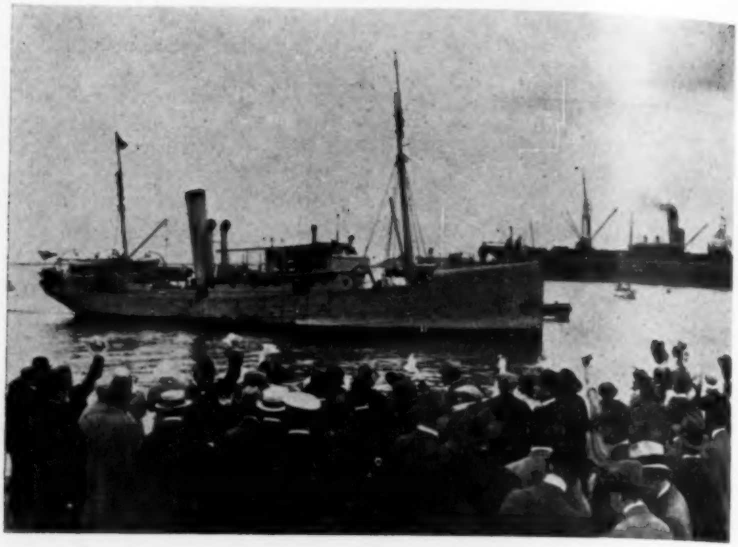
THE BIRTHPLACE OF THE EELS

The final chapter in the life story of the eel has been written by the Danish expedition under Dr. Joh. Schmidt, which has recently returned to Copenhagen. The breeding grounds have been found between the Bermudas and the Leeward Islands, where the sea reaches a depth of more than a mile.

The origin and mode of reproduction of the common eel have been for centuries a matter of speculation. It has long been observed that large eels migrate toward the sea in autumn and that in the spring little elvers are found under stones on the seashore and ascend the streams in vast numbers. A group of small transparent salt water fishes, known as Leptocephali, were described in 1763, but no one guessed that they were in any way related to the eels.

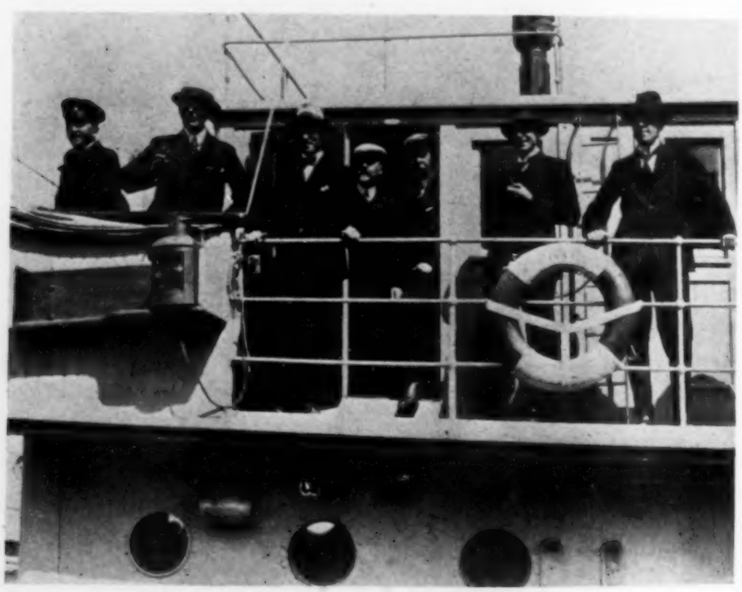
In 1864, Theo. N. Gill, of the Smithsonian Institution, published the conclusion that these Leptocephali are the young or larvæ of the eels, and this was confirmed through direct observation by Yves Delage in 1886. Beginning the following year, Professor Grassi made careful studies of the development of the eel in Sicily, observing the transformation of Leptocephali into the conger and other genera of eels, and in 1894 the larva of the common eel was discovered.

It was evident that the spawning of mature eels occurred in the sea, and now the place has been discovered by Dr. Schmidt. The European species deposit their eggs to the south and east of the Bermudas, while the American species breeds to the south and west of the islands.



Wide World Photos

The ship *Dana*, returning to Copenhagen with the Danish deep sea expedition which found the breeding place of the eel near the Bermudas.



Wide World Photos

The *Dana* at Elsinore, where it was boarded by Prince Valdemar of Denmark and Prince George of Greece, both of whom are seen in the door of the cabin, while the leader of the expedition, Dr. Johs. Schmidt, director of the Carlsberg Laboratory, is seen at the extreme left.

The former make a three-year migration to the shores of Europe from the North Sea to Italy, while the latter journey to the American coast from New England to the south in a few months or a year.

The Leptocephali after their transformation into elvers ascend the streams and sometimes travel overland from stream to stream or up the faces of dams and along the sides of rocks in search of sufficient water. The eels live for years in fresh waters, the period being from five to as many as twenty or thirty. In the autumn some of the mature eels travel back to the sea, the males then being from twelve to eighteen inches in length, the females never less than eighteen. At the original breeding places they spawn and die.

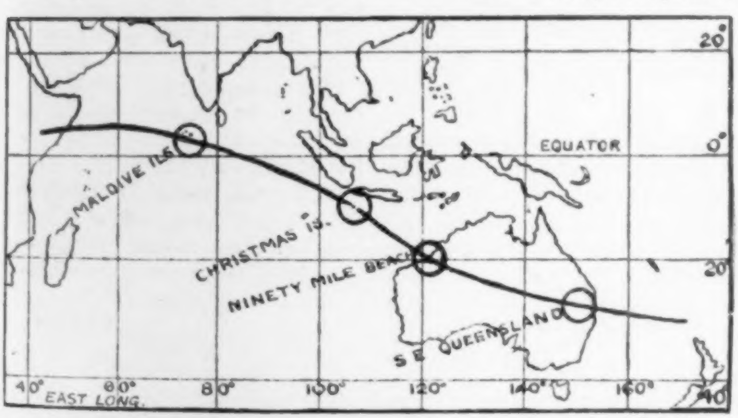
THE TOTAL SOLAR ECLIPSE OF SEPTEMBER 21

By Isabel M. Lewis
Science Service

Some of the points at which eclipse expeditions were located on September 21 are the Maldive Islands in the Indian Ocean, Christmas Island about 250 miles south of the west end of Java, Wallal on the western coast of Australia, Cordillo Downs in central Australia, to which instruments and supplies were transported by camel trains from Adelaide, South Australia and Goondiwindi in the southern part of Queensland. The longest duration of totality was five minutes and nineteen seconds at Wallal.

The Kodiakanal Observatory expedition from South India in charge of Director Evershed was in the Maldive Islands. On Christmas Island the eclipse was awaited by expeditions from the Royal Observatory of Greenwich and the combined expedition from Holland and Germany which were joined by observers from Java. The British expedition has been on the island since the last of March making extensive preparations for testing the Einstein theory of relativity. It is essential for this purpose to photograph the field of stars in which the sun will be found at the time of eclipse several months before or after the eclipse date. If, as the Einstein theory requires, the rays of light from stars near the sun are deflected from their course at the time of eclipse owing to the attraction of the sun's mass, a comparison of photographs taken when the sun is in this field of stars at eclipse with photographs taken several months previous when the sun was not in the field will show the displacement of the star images required by the theory.

A number of eclipse expeditions



From *Nature*.
Shadow track during total solar eclipse of September 21, 1922.

were located at Wallal, West Australia, owing to the generosity of the Australian government in placing at the disposal of the eclipse expeditions a transport of the Australian navy.

Some of the expeditions that accepted this offer of the Australian government are the Crocker eclipse expedition of the Lick Observatory, California, in charge of Professor W. W. Campbell; an expedition from the University of Toronto which included Dr. R. K. Young, of the Dominion Astrophysical Observatory, Victoria, B. C., and an expedition from the Observatory of Perth, West Australia. The transport left Freemantle, the port of Perth, the last of August and will bring members of the expeditions back to that port after the eclipse.

The chief object of several of the expeditions was to test the Einstein theory which requires that stars near the sun that are visible when the sun's rays are temporarily blotted out shall be displaced from their normal positions by amounts depending upon their angular distances from the rim of the sun. It will be recalled that the deflections both in direction and amount required by theory were obtained by the British observers at Principe, Africa, and Sobral, Brazil, at the time of the total solar eclipse of May, 1919. This is the first opportunity that has been afforded since that date to obtain an additional test of this prediction of the relativity theory.

SCIENTIFIC ITEMS

WE record with regret the death of William S. Halsted, professor of surgery at the Johns Hopkins Medical School; of Rollin D. Salisbury, professor of geographical geology at the University of Chicago; of Dr. Harold C. Ernst, professor of bacteriology in the Harvard Medical School; of Stephen Smith, distinguished for his contributions to public health, who had nearly reached his hundredth birthday; of Arthur Ransome, the English authority on public health, who died at the age of ninety-two years; of W. H. Hudson, the English ornithologist and writer on natural history, and of Edward M. Eidheer, formerly expert in the Austrian bureau of chemistry.

THE British Association for the Advancement of Science held its ninetieth annual meeting at Hull from September 6 to 13 under the presidency of Sir Charles Sherrington, professor of physiology at Oxford and president of the Royal Society. Professor Mangin, director of the Paris Museum of Natural History, presided over the meeting of the French Association for the Advancement of Science held at Montpellier from July 24 to 29.—The Association of German Scientific Men and Physicians held its hundredth meeting at Leipzig from September 18 to 24. One of the public addresses was by Professor Albert Einstein.

A PRIZE of $25,000 to be awarded annually to a chemist of the United States for contributions to chemistry was announced by the Allied Chemical and Dye Corporation of New York, at the recent Pittsburgh meeting of the American Chemical Society.

THE French Senate has unanimously voted 2,000,000 francs to observe the hundredth anniversary of the birth of Louis Pasteur, which will take place this year. The Senate in voting the appropriation described Pasteur as the "symbol of French science."

THE late Prince of Monaco has bequeathed sums of one million francs each to the Academy of Sciences, the Academy of Medicine, the Institut Océanographique, the Institut de Paléontologie Humaine of Paris, and the Musée Océanographique of Monaco.